Beef Branch

UNITED STATES DEPARTMENT OF AGRICULTURE

AGRICULTURAL RESEARCH SERVICE

ANIMAL SCIENCE RESEARCH DIVISION

and

COOPERATING WESTERN STATES

W-1 - IMPROVEMENT OF BEEF CATTLE THROUGH THE APPLICATION OF BREEDING METHODS

Joint Meeting of WRCC-1, NC-1, and S-10 Technical Committees,

Termination Report of W-1,

and

Report of

Annual Meeting of W-1/WRCC-1 Technical Committee

August 10-12, 1970
U. S. Meat Animal Research Center
Clay Center, Nebraska

This report is intended for the use of administrative leaders and workers and is NOT for general distribution.

JOINT MEETING

REGIONAL BEEF CATTLE BREEDING TECHNICAL COMMITTEES

U. S. Meat Animal Research Center
Clay Center, Nebraska

August 10-12, 1970

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JOINT MEETING
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NC-1, S-10, WRCC-1

U.S. Meat Animal Research Center
Clay Center, Nebraska

August 10-12, 1970

Monday, August 10

Morning	Chairman--L. V. Cundiff
8:30 a.m.	Welcome--Ralph Hodgson
8:40 a.m.	The Beef Cattle Industry--Nature and Future Research Requirements--Lavon Sumption
9:10 a.m.	Discussion--R. L. Blackwell, Leader
9:45 a.m.	Coffee
10:00 a.m.	Beef Cattle Breeding Research and the Industry It Serves-- Important biological and economic problems and the scope of beef cattle breeding research required--L. A. Swiger An evaluation of beef cattle breeding research: Are programs "tuned in" on the industry's problems? Do we reflect an adequate sense of urgency? The impact of estrus control, A.I., sexed semen, and other beef cattle breeding technology on germ plasm control and management--L. N. Hazel
11:00 a.m.	Discussion--James Brinks, Leader
12:00 noon	Lunch
Afternoon	Chairman--Keith Gregory
1:00 p.m.	The U.S. Meat Animal Research Center--Keith Gregory Development Status Present Beef Cattle Research Programs Goals

2:00-6:00 p.m.	Tour of U.S. Meat Animal Research Center--Walt Rowden and Hudson Glimp
6:30 p.m.	Refreshments and dinner

<u>Tuesday, August 11</u>

<u>Morning</u>	Chairman, Will Butts
8:30 a.m.	The Role of Research in Characterising Germ Plasm Resources Identifying optimum adaptability to specific feed, climatic, and production environments. Relationships among fertility and optimum growth curve, mature size, milk production, etc.--T. C. Cartwright
9:00 a.m.	Evaluation of Breed Differences--Gordon Dickerson
9:30 a.m.	Programs to Utilize Breed Differences--Howard Fredeen
10:00 a.m.	Coffee
10:15 a.m.	Discussion--Will Butts, Leader
12:00 noon	Lunch
<u>Afternoon</u>	Chairman--T. C. Byerly
	Meeting Beef Cattle Research Requirements Through Joint Planning and Cooperative Execution
1:00 p.m.	Regional Goals for Cooperation with the U.S. Meat Animal Research Center-- J. W. Turner, Chairman, S-10 Technical Committee R. M. Koch, Chairman, NC-1 Technical Committee Curt Bailey, Chairman, WRCC-1 Technical Committee Response--Keith Gregory
2:45 p.m.	Coffee

3:00 p.m.	Report of the Joint Study Committee on Beef Cattle Research--E. J. Warwick and J. A. Whatley, Jr.
4:00 p.m.	Discussion--T. C. Byerly, Leader
Evening	Chairman, Ralph Hodgson
7:30 p.m.	The Canada Department of Agriculture Germ Plasm Evaluation Research and Import Program--August Johnson
7:50 p.m.	The proposed USDA Cattle Import Program--A Status Report--E. J. Warwick
8:10 p.m.	Texas-Argentina Cooperative Evaluation Programs--T. C. Cartwright
8:30 p.m.	Discussion--Ralph Hodgson, Leader

Wednesday, August 12

Morning	Chairman--Bradford W. Knapp
8:00 a.m.- 9:45 a.m.	Administrative Reviews (Analysis and perspective of matters covered by program on August 10 and 11) Paul Putnam Estel Cobb Roy Kottman Martin Burris Doyle Chambers
10:00 a.m.	Independent meetings by: WRCC-1 NC-1 S-10 Adjournment

U.S. MEAT ANIMAL RESEARCH CENTER TOUR
by
JOINT REGIONAL BEEF CATTLE BREEDING TECHNICAL COMMITTEES

The tour of USMARC facilities by the Joint Committees on August 11 was preceded by a statement by Dr. Keith Gregory, Director of the Center, on the development of the Center to date, livestock populations currently involved in research programs, and future development of facilities and research programs. Members of the tour group then were loaded on buses at the Clarke Hotel in Hastings, Nebraska, and embarked on a tour of the Center.

During the three and one-half hour tour of the Center, participants were shown much of the land and associated resources available to the U.S. Meat Animal Research Center for utilization in research programs. Of particular interest to the group was the observation of beef cattle and sheep populations currently involved in various experimental programs. Observed were beef cattle populations of the Hereford, Angus, Milking Shorthorn, Red Dane, Brown Swiss, Red Poll and Charolais breeds and approximately 950 Hereford and Angus females with calves from seven breeds of bulls in a major germ plasm evaluation program. Breeds of bulls used in this study were Simmental, Limousine, Charolais, South Devon, Jersey, Hereford, and Angus. At the several stops made to view these cattle, MARC scientists outlined the research objectives for each group of cattle.

Major developments of facilities outlined on the tour included a 3600 head capacity feedlot for beef cattle growing and finishing program and cow-calf confinement feeding research, new headquarters laboratory and office complex, and feed mill and animal research facilities.

A brief tour of the sheep research facilities and discussion of sheep research programs was also included.

WELCOME STATEMENT

R. E. Hodgson, Director
Animal Science Research Division

It is a pleasure for me to welcome each of you to the U.S. Meat Animal Research Center and to wish you every success in your meetings. I believe it is significant that the Committees of the three regions are meeting together at this time and at this place.

A perusal of the program before you suggest that important questions regarding elements of breeding research are to come under intensive examination and review. We are pleased that our colleagues from Canada are here to inform us of their research and related programs.

I note that considerable emphasis is being placed on cooperation in this research and how to more effectively plan, promote and execute cooperative research across State lines, between Federal and State, and across country borders. This is as it should be. We all are in this work together, we are responsible for use of public funds, we are working for the same interests, and we all stand to gain by working together. There is much to do and enough room for all the scientists we can bring to bear on existing problems, both State and Federal.

We are glad for the opportunity to show you the progress that has been made and the present status of the USMARC. To us progress has been slow only because financing has been slowed, but we are very much on the way. The staff here is dedicated and has made unusual progress under the conditions. The move into the new facility soon to be made will be a milestone of progress. We can now begin staffing our scientists as fast as funds will permit.

I continue to view this Center as an outstanding facility and a needed one to help conduct the required research on meat animals. While it may carry the Federal label, it is here to produce information that is needed and will be useful to the meat animal producers. The program will be a cooperative one to the extent that we all will make it so and it will supplement and complement that which is being done by other institutions working on meat animal research. In this regard it is our intention to make this program truly a part of the total national cooperative program for beef and meat animal research. I anticipate that many of the projects at the Center will be contributing ones to appropriate regional research projects in the different regions.

As you know, the beef cattle industry is presently undergoing revolutionary changes, and these changes will continue. This is particularly true of the breeding aspects. Similar changes are needed in other aspects of production. In order to properly guide these changes new information is needed and this information must come from the research laboratories. The challenge to all of us is to come up with this needed information. The additional challenge is to keep abreast and, insofar as possible, ahead of the game so that the industry can be served effectively.

So welcome and good success in your work.

THE BEEF CATTLE INDUSTRY--ITS NATURE AND FUTURE RESEARCH REQUIREMENTS

Lavon J. Sumption
Staff Member, Ankony Angus Corp., Stanford, Montana
Consulting Geneticist, Prairie Animal Breeding
Enterprises Ltd., Edmonton, Alberta

It is a special privilege to return to the company of many former colleagues on the occasion of your first joint meeting in ten years when you are inspecting the results of early development of a new research station that will represent significantly increased activity in beef cattle research and while you are reappraising your total research programs. It will be pleasant to participate again in your challenging forum of critical debate. Much of what I have to say has been debated with many of you. Some new thoughts and further convictions may be underscored. It is encouraging that more of you agree with me now than when I first started attending regional animal breeding meetings in 1954!

Your meeting chairman has invited me to express my own biases on the indicated topic which I will limit drastically as a result of kind advice given me in the mid 1950's. On the occasion of reading my Ph.D. thesis literature review, Dr. Joseph Gall, the well known cytologist at Minnesota, made only one summary comment which was more worthwhile than detailed editing--"You don't have to justify the whole field of genetics!

For me to review again at length, the well worn cliche that beef cattle breeding is undergoing tremendous change, implying in vague platitudes that change may represent progress, would be a serious waste of the time we need for orientation toward the tough issues at hand, namely the efficient use of our resources to maximize the improvement rate for carefully chosen economic traits. Just as we have crossed the threshold of the space age and the dawning of the age of Aquarius, cattle breeding is evolving. We are participants in the dawning of the age of Industrial Animal Breeding. The way was paved for cattle breeders by applications in corn, poultry and to a lesser extent swine. Although frequent reference has been made to these forerunners in other species as a potential pattern of what could happen to cattle breeding, few research workers have seriously considered the implications on industry structure, opportunities for changing profit centers in the beef industry or the extreme challenge it poses for professional animal breeders. I would like to suggest to you from first hand observation that Industry Cattle Breeding has arrived; it plans a long tenure as a serious customer for ideas and to be a responsible source of germ plasm for commercial production. If you find I have been influenced heavily by the views of Lerner and Donald, I will readily plead guilty, together with experience gained during a limited amount of industry consulting during the past twelve years.

Now that my orientation has changed from a producer of evidence to a consumer, I want to thank you especially for giving me an opportunity at this meeting to make some observations and certain urgent requests.

Time Consciousness

We must increase our concern for time in cattle breeding. Although there has been a great deal of optimism about cattle breeding recently, I would suggest that generally beef cattle breeding has been a depressed area that is lucky to have escaped the scrutiny of welfare agencies. Though economic crises have occurred, the most serious problem has been the idea crisis. There has been an inordinately long generation interval between a useful idea to major action programs. The gestation length has been excessive, the births have been difficult even though some of the ideas weren't really so large, the birth canal of acceptance was small and almost always it has been a backwards calf! We should be cognizant of the most likely causes of these long generation intervals which include:

1. Hyperconservatism of professional animal breeders and their colleagues in animal science teaching and extension. It wish to dwell on this matter. Although we have been reasonably successful in eliminating the witchcraft and quackery from teaching and practice in animal nutrition, management and physiology, the same departments (perhaps even the same people) are still mixing sizable helpings of folklore in with scientific animal breeding. Practical breeders have received entirely different recommendations from different staff members in the same department. The only way I can help you with that problem is to remind you and your administrators that it exists; you can increase your effectiveness if you can get on a similar wave length.

   Another symptom of narrowness is to examine the percentage of cattle breeding research in the United States regional projects conducted with registered, straightbred, purebred Angus and Herefords. However, during all the years since the regional projects were initiated, more than 15 breeds of cattle were present in North America.

   How often have you used that time-honored but useless political statement "there are good ones in every breed; all you have to do is find them" without referring to the necessity of achieving a high population frequency of the best performing material quickly that animal improvement procedures will permit us to produce?

Part of the conservative political cloak animal breeders have worn is one of telegraphing their criticisms by saying "I know breeders of Breed X are going to be upset about these results, but...". Is it not time to speak cooly and logically from your research evidence and your most carefully considered predictions without either weakening your message or giving it emotional overkill? Please tell it like it really is and reserve the business decisions of application for the industry. Research not politics is your business.

I have heard this group pay great homage to purebred breeders and breed organizations and place great reliance in the future of precisely this same structure as the medium for genetic improvement programs. Have you examined your objectivity on this matter lately? The only thing we know we received from the renowned breeders of the past are animals; the real issue is how the industry will use these most necessary resources and what structure will best serve total needs to maximize increased rates of efficient production. In the past, new organizations with new approaches (including the first companies to undertake industrial animal breeding programs) received unfavorable treatment at the hands of most professional animal breeders and especially their colleagues who were not animal breeders. Although this matter has changed, there is an emotional tendency to identify closely with the small farmer-breeder whose applied population genetics non-program frequently represents an exercise in near futility. Just as we examine alternative breeding systems for population improvement it is time for you to examine carefully alternative structures for the industry you may serve in the next 20 years and your relationship to it. These are the key messages from (a) Lerner and Donald, (b) the annually unused genetic improvement potential of our national herd, and (c) future economic pressures on efficient cattle production.

Some professional animal breeders still judge conventional livestock shows! Apparently the correlations between conformation and productivity are approaching unity as a result of evidence reported in the past year! I don't wish to spend any more time condemning shows however because they do represent a pleasant social event. More emphasis is now given to weight for age and carcass contests that acquaint youth, adults, and other consumers with the product. Furthermore, there is a movement to establish cattle as industrial exhibits in State Fairs competing directly for business through describing their breeding program rather than asking the general public to pay breeders to exhibit cattle in the show ring. The Montana State Fair was the first one to eliminate competitive live showing, much of it because of the pioneering efforts of Lloyd Schmitt, Ankony's Montana manager (as a matter of fact, the first time I ever washed cattle for a fair was for this industrial exhibit!).

2. Conservatism of private breeders--who have an economic enterprise to protect, for which the status quo often seems the safest course. Their natural tendencies are frequently fortified by the mixed views they receive from various university staff, livestock judges, salesmen, commission men, other breeders and their customers.

3. Industry rules and systems--can be major deterrents; for example:

   a. Worship of the 600 lb. beef carcass

   b. Dwelling on elements of shape or color that have no direct economic value

   c. Restrictive A.I. policies of breed societies.

4. Failure to understand the total business elements of cattle production from conception through marketing, consumption and financial analysis of alternative systems. A very wise person whom many of you know observed recently that he doubted that there was any other business in which so many primary producers had so much invested that knew so little about the final product and its processing.

5. Lack of awareness of world industry developments through inadequate communication and travel. It pays to know what innovating neighbors both near and far are doing.

I would plead with you to provide leadership to create a climate of thought in which it is possible to shorten the interval from idea generation to industry action.

Structure of Beef Breeding in the Future

Specification consciousness is increasing in the cattle business, as cattle breeders evolve genetic inputs to deliver a specific output. Most of what I will describe in this section is by no means prophetic because it already exists somewhere in the North American beef industry. The main point for debate is the extent of impact of these concepts and practices:

1. There will be a total orientation toward systematic utilization of heterosis. Economic needs alone will force use of methods designed to capitalize on these attractive increases in productivity. The emphasis on specific crossing of three or more breeds will grow if the profit advantages at the terminal cross level are great enough despite the higher specialization these systems demand. Breeding companies will evolve innovative systems to produce

hybrid heifers in large numbers. This movement is already operative for both internal use and sale in several states and provinces, most commonly with Angus x Hereford cows mated to Charolais bulls. The use of Holstein and Brown Swiss cross cows is increasing.

2. Seed stock breeders are more likely to maintain two or more breeds to provide more of the genetic input for a complete controlled heterosis program. Their business policy will be "how can I breed a better crossbred product."

   Within 15 years it is not only possible but likely that less than ten breeding companies will produce most of the genetic stocks used by commercial cattlemen because:

   a. There is a favorable business opportunity. Nobody has any genetic "lead time".

   b. These companies will be prepared to maximize improvement rate by selection within and between populations.

   c. Extensive financial and professional resources are required to engineer and merchandise superior meat animal germ plasm and develop a sufficient variety of populations to satisfy markets for different environmental situations.

   d. The market, both at the level of the cattlemen and beef buyers is becoming more specification conscious, requiring more intensively specific efforts than most breeders are willing or able to provide.

   It would be surprising if there were not a difference of opinion on this prediction. It might be well to see how many seedstock herds in any breed provide a majority of the germ plasm now. I suspect that actual count might be less than one third of your first estimates.

   Major breeding companies will supply both semen and bulls to permit development of specification programs of high genetic merit. Present artificial insemination companies either will control the breeding structure of cow herds supplying their stud bulls or the companies will be owned by breeding organizations who have such a structure.

3. There will be a quickening pace of improvement because of economic demands the most important of which is breed and breeder competition. The Charolais breed jarred North America's cattle industry out of 30 years of lethargy and pendulum swinging. Canada's breed importation served permanent notice that things will never be the same again.

Without these two factors, performance selection and systematic crossbreeding might have moved much more slowly. Now beef producers will take a second look at nearly any plausible program and variety of genetic raw material.

To be competitive, breeders know they must have valid performance data. This is not easy with the newly imported breeds (mainly bulls) that have no North American "track record". Extensive progeny tests are underway to compare individual sires of new breeds including sire groups from "the competition" to put breeds in perspective with one another. For example, one private Canadian cattle breeding company has established a policy to place each of their imported bulls on progeny test immediately, together with a standard carry-over bull so accurate ranking of all their bulls will be accomplished. As a further example, one of Ankoney's new industry services is a National Sire Evaluation program for sire progeny testing. It was started with 20 Charolais bulls in 1969. In 1970, NSE was expanded to include all Limousin sires then available for A.I. use in the United States, on a test at one location, with 50 calves anticipated from each sire. The policy will be to test all new sires for which suitable arrangements can be made. Never will so much be known about all the foundation sires of a breed so quickly by so many breeders. Custom progeny testing services will be offered to other breeds on demand.

Regarding future business structure, there is another sensitive area dealing with weaning procedures. Record of performance work is past the strictly educational stages for the cattlemen who are most vitally concerned. Some breeders have begun to look at R.O.P. work as your program rather than business effort for which they should bear total responsibility. Is it time for University livestock extension personnel to wean themselves from this business service of record collection and get on with other educational work (e.g. use of the existing records in optimum selection and mating systems)? How many states have their own independent beef performance data processing systems? Are they still being used in an educational phase or should you be weaning yourselves from this area of competition with private enterprise? The weaning process probably would reduce the total number of herds involved in collecting performance data; I am not convinced it would seriously change the number who use these records as vital business tools. The national volume of beef performance records is not large enough to support many private data processing businesses. The amount of potential business drained off by highly subsidized state programs may be just sufficient to stifle full development of the most innovative private services. If your job is to foster understanding until sound ideas have been translated into effective action, we hope you keep perspective to recognize when

it is time to withdraw. We don't believe the argument is valid that you would lose contact with breeders if someone else weighs the cattle and processes the records. If so, you never had a good business-educational relationship. If you stop doing chores you'll have more time for education.

Whether we agree on what changes may occur in the beef industry structure relative to your role in it is not important. The significant thing for us all to recognize is that old traditional approaches will be as outdated as a barn full of 1965 bulls. How will you respond?

Research Plans

In the past ten years, the attitude of cattlemen toward research has changed drastically. Unfortunately, the questions that were considered too "far out" a few years ago to secure popular support now require answers rather than the initiation of the research to reach conclusions. We return to the necessity of time consciousness on your part. Whether you like the risks or not we expect workers in animal breeding research to look way ahead, do the "far out" work and get the answers while they are still ahead of industry requirements. How else can research contribute efficiently to leadership and progress? You have to consider target dates for when your work will be ready for public consumption. If you're projecting work now that is required by the industry much before 1980, you haven't got time and should re-align the use of your resources. The industry will have to make its own guesstimates and look to you only for confirmation, which is not the most satisfying role.

In order to do this kind of work you must have an academic and administrative environment that provides full resource support. Finances, and competent technical personnel are vital but secondary to a favorable climate of thought that stimulates the very best from its scientists, and interprets their role to the public in the most positive way.

Let us examine some areas of work that require comments:

1. Parameter estimates--new heritability values we do not need. I tend to agree with H. P. Donald, "... tell me the trait and I'll tell you the heritability." The industry does need to know more about realized heritabilities derived from comparing alternative improvement programs which we have never provided to date.

2. Breed evaluation--is pertinent relative to choice of foundation material for tomorrow's specification breeding

programs. Animal breeders lost the ball in the first phase of this effort (with a few exceptions such as the continued encouragement offered by Ralph Phillips and the late R. T. Clarke who pleaded with us to evaluate new source materials). Now private enterprise in North America has applied enough pressure to get us moving again.

No longer does the "one breed" economy apply. Breeds must be evaluated at the crossbred level to arrive at combinations both for seedstock building programs and commercial crossbreeding.

Some of you will be sensitive about an article to appear in the cattle press shortly on breed evaluation, contributed by several workers at this meeting. This article was planned only to review what is presently known or estimable, predicated on the fact that cattlemen must make some decisions now regarding breed choices while additional data is gathered.

We do not expect experiment stations to do all of this work alone. You cannot devote enough resources to this one area. However, please do your share and cooperate with private breeders. You can make a special contribution in evaluating maternal performance of breeds because industry will not do that part accurately. We hope you will work well beyond the presently accepted range (e.g. Cartwright's "Ajax" project with Jersey x Angus cows mated to Charolais bulls).

3. Selection studies--need to be increasingly specialized. The plateau effect must be effectively partitioned. I believe one segment is caused by idea loss of the researcher-breeder whereas the other is undoubtedly a loss of useful genetic variance. There are still too few projects aimed at comparing contrasting foundation populations where a deliberate attempt has been made to increase genetic variance. We have numerous examples in plant and lab animal breeding to suggest its value but we are as narrow in our thinking as the Holstein-Leghorn straight-jacket that restricts the action of some of our colleagues. Please pardon me if I fail to advocate relaxed selection lines for beef cattle because there is probably no other species that has been in such a prolonged state of relaxed selection.

4. Cow efficiency studies--represent true interdisciplinary work. We need your help desparately on this matter. We know it will demand your best. Should we design breeding systems to use genetically small cows or is it economical to restrict through feeding the genetic potential for mature weight to achieve lower maintenance requirements?

5. Crossbreeding systems--what is the most efficient way to combine and use productive breeds that have widely different genetic traits? These workers who find specific crossing too awkward for general industry use, should submit evidence from valid experiments proposing more efficient systems.

6. Pilot breeding experiments--with computers, mice, pigs and sheep all represent laboratory work for the cattle industry and provide a means of testing methods before the final screening of the most promising residual is attempted with the slow generating, expensive cattle beast.

One major policy issue deserves comment at this point. We do not expect research workers to turn out "finished" germ plasm ready for industry use. I do not believe you are geared for it. To complete the "fine tuning" and to maintain source material you would occupy resources that we believe must be used otherwise. At one time you could have performed that function when the industry was not equipped, but that era is past. However, you cannot escape responsibility for providing us with evidence that will help us build better breeds, even if it means burying certain unproductive breeds.

Building the Germ Plasm Resource Pool

This program deserves special consideration because this is the source of raw material for long term improvement. At this meeting you will discuss progress in the Canadian program and its cooperation with Clay Center. In developing its own cattle quarantine station the United States can learn from Canada:

1. The Canadian industry applied the pressure to initiate the program once techniques were adequate to protect national herd health; the idea did not originate with government alone. Then it took the courage and forthright action of Harry Hays, then Minister of Agriculture, to set the program in motion.

2. There <u>are</u> many other productive breeds available in the world, besides the British breeds which have dominated the picture up to now.

3. U.S. breeders demonstrated a healthy interest in the imported breeds by purchasing cattle and semen from Canadians, a great help to the private balance of payments, of Canadian importers.

4. Policies on permit distribution have varied and have had only a limited reflection of genetic planning:

a. During the first two years, the program was not limited to cattle owners. Generally, a single importer was granted only one permit per year. No ownership requirements were imposed, that is, the importer could divest himself of the title at any time. A majority of the first two shipments were sold and moved to the United States within six months after release from quarantine.

b. No attempt has been made to restrict the numbers per breed, the breeds or the sex ratio of imported cattle from eligible areas, which at first included only France, later Switzerland.

c. More recently the import applications have been limited largely to cattle owners who sign an affidavit to hold title to imported stock for three years. Applicants must file an intended breeding program including a plan for future importation, testing and selection. The objective of this approach was to attempt to place imported breeds in herds with a higher probability of contributing to breed establishment and improvement of national genetic resources. In practice individuals have still received only a few (e.g. 1-4 permits) per year. To insure greater use of imported cattle to increasing Canada's national herd resources, direct imports or female progeny born to imported dams cannot be moved permanently to the United States for three years. Bull progeny can be exported upon application. Generally, applications for different breeds have been approved in direct proportion to the indicated interest without regard to the numbers previously imported. The same breeder has not been eligible to import more than one new breed.

d. Officially, knowledge of the successful applicants has been a "confidence between the applicant and the Minister of Agriculture," except for note comparing that would logically occur among acquaintances until importation is completed. This policy has permitted the seller-exporter to deal with the importer individually for one or two animals with the net effect of increasing the average price per animal.

e. The government imported cattle beginning with the third year, for research purposes, but of the same breeds as private importers.

f. The total annual quarantine station capacity is more than 600 cattle, divided among one quarantine at Grosse Ile and two on St. Pierre, a French island off Eastern Canada.

I would suggest the following matters are fundamental to the United States animal importation program.

a. General policy--should be established by a government body with advisory participation by livestock breeders. This body could operate in the public interest for development of natural resources in exactly the same way as germ plasm development for plants, soil conservation practices, mineral resource use policy, etc. This is the level where you the professional animal breeders should provide your views. Many of you need to acquaint yourselves thoroughly with a greater array of the world's germ plasm than you now know in order to advise intelligently.

b. Material choice--which species should be considered? So far the total emphasis in Canada has been on cattle because of industry interest, and adequacy of health tests. Should the program be broadened?

   Importation costs to importers and government are high enough so that an annual review is justified to consider the species, breeds, relative numbers per breed and the sex ratio per species--breed combination. Industry demand should be conditioned by sound genetic planning. For example, in the Canadian program there has been continued interest to import Charolais long beyond the numbers required for adequate genetic sampling. Heavy emphasis is given to importing females when the genetic contribution of a female to the multiplication of the national herd is highly restricted, coupled with the fact that this perpetuates the purebred philosophy, when in fact we may not wish to have North American cattle that completely identify with the genetics of the original source material. It is likely that some domestic Charolais cattle will remain under-appreciated in total performance value because it has been more fashionable to have the French background even if unappraised for performance.

c. Source of material--what countries have material deserving consideration? If these areas are presently "off limits" health-wise, what measures can be adopted to evaluate potential by (i) conducting research in the original area, sending known parent material from North America for comparison and/or (ii) beginning a progression of country by country, island by island transfers to bring useful genetic samples to regions from which importation is feasible. This suggests a long term commitment, but I believe we expect to be engaged in livestock production long enough to justify realistic inputs.

d. Eligible participants--this is a problem plagued with a combination of genetic and political logic. There are two general levels of approach. In the general public interest, government justifiably could be the sole importer, devising a sensible formula for subsequent release of useful seedstock to the industry. Alternatively, a government-industry committee must choose from among thousands of applicants who have the most plausible breeding programs and are likely to provide for the most effective testing and multiplication of the new resources. Either approach can serve industry requirements. Immediate private participation has insured broader early testing, general public interest and speculation (not totally undesirable). In the interests of devising a program that will insure establishment of genetically viable herds, it would be better to provide a few breeders per breed with sufficient imported animals to (i) require a major financial commitment insuring serious business efforts, (ii) permit a breeder to acquire enough animals at one time to allow for orderly genetic development of a nucleus herd. Then there is the political issue. However, if there are 2000-3000 applicants for 500-700 imported animals is there really a serious difference in political risk if 50-75 applicants receive 5-10 animal permits per applicant? The former strategy would justify shifting major emphasis to other applicants in subsequent years.

e. Nature of government involvement--originally only private breeders participated in Canada's program. Now the government has become an importer of Simmental and Limousin to (i) participate in impartial breed evaluation and (ii) avoid private monopolistic approaches on early semen sales. Since these C.D.A. programs were initiated there has been sufficient growth of private custom progeny tests of comprehensive scope to obviate a separate government breed evaluation program, with the possible exception of appraising maternal traits of new breeds (this does not require the government to be an importer). Competitive selling has prevented exorbitant semen prices.

At this point I believe the only justifiable participation of government as an importer is to introduce breeds or species that possess potentially valuable traits but the animals in question require major research and development to engineer a genetically valuable commercial entity. Private enterprise may not be able or willing to make the investment, but government in the public interest may do so.

f. Relationship between the Canadian and the eventual United States importation program--has not been generally discussed but some joint policy decisions should be resolved. Resource development will not be well served if the two importing countries are "competing" in the same exporting countries for the same genetic material. Canada has the lead time for cattle from France, Switzerland and no doubt very soon from Italy and Germany. It may be too logical to be acceptable that the United States should explore other countries which Canada has not considered and/or direct its main attention to species other than cattle.

The cooperative research initiated by the U.S.D.A. at the Meat Animal Research Center together with C.D.A.'s research stations at Lacombe and Lethbridge, Alberta, and Brandon, Manitoba, sets a real precedent. Let us hope it will foster further cooperation on policies for use of livestock importation quarantine facilities and animal breeding research.

Whither Animal Breeders

In the near future, industry developments will depend more heavily on consulting geneticists than on animal breeding research workers because you will not have many new facts to sell for sometime. We welcome your participation as consultants but please make enough of a commitment to put your "feet to the fire!" We hope you will share your thinking with us so we can help translate your best ideas into industry action. It is our responsibility to provide you with feedback from the industry. We are talking about the viability of a partnership. Industry recognizes that one of their important partners for progress is research. Consulting geneticists and research workers can provide two vital links in the chain of communications and action. We support you fully in establishing research programs that will answer tomorrow's questions today!

There has never been a better opportunity to apply population genetic concepts to large animal improvement programs. Natural business evolution and the growth of animal breeding knowledge have both contributed to the cattle business reaching a stage of maturity and sophistication that can be defined truly as Industrial Animal Breeding. The industrial climate has never been more receptive to your most progressive ideas. We hope you will give us your very best.

IMPORTANT BIOLOGICAL AND ECONOMIC PROBLEMS AND THE SCOPE OF BEEF CATTLE BREEDING RESEARCH REQUIRED

L. A. Swiger
The Ohio State University

I thought the title I was given hinted at the possibility of some different lines of research in beef cattle breeding in the future. Notice the word biology. We also inserted that word in the first objective of the newly written regional swine breeding project. Perhaps our research will become more fundamental in terms of understanding what is happening and why inside the beef animal. I almost said that our research will become more basic, but I am reminded of Herb Kramer, when he was the brand new Director of the Experiment Station at Nebraska, terminating the usual fruitless discussion of classifying research with the following remarks. "There is good and bad applied research. There is good and bad basic research. At Nebraska we are going to do good basic research and good applied research and we won't necessarily know which is which."

Research, including agricultural research, has come to involve so much money that two things have happened which are detrimental. (1) Administration has proliferated beyond reasonable bounds, and (2) the political involvement has become too strong an influence. The net result is that the dollar overhead is high, the overhead for the researcher's time is high and decisions on what research will be done has moved away from the research worker. He is planning projects to "capture" funds rather than exercising his wisdom in determining and designing research projects. Using such words as interdisciplinary, multidisciplinary, team, programmed, problem solving, task force as well as pollution, ecology and environment is more important in getting funds than tackling good problems. We will have to make up our minds to fight this battle.

The original dream of USMARC (then referred to as Hastings) as I shared it mostly with Keith Gregory but also Bob Koch and Dr. Baker, was a research organization where some projects would be closely planned, tightly run, team projects. Others would be clearly within a discipline but with free sharing of ideas and suggestions of colleagues of all disciplines. Still others would allow individuals to try their brainstorms relatively unmolested. I hope this persists along with the more idealistic intent of incorporating people and ideas from other stations.

I look on future beef breeding research as a continuation of going after the fundamental facts, such as breed and heterosis effects and parameters for maximizing the efficiency of selection,

with considerable more emphasis on unraveling the biology. There is always the chance for that hoped for, but usually not planned for, major breakthrough that is really "big guns" in terms of basic knowledge or application or usually both.

Most of our research in genetics is done under one or two management schemes. If we get out answers only in terms of production traits it is difficult to extrapolate to broader questions. If we understand the basic phenomena of what happened in our experiment, e.g. the in's and out's of energy utilization, we are in a better position to argue questions concerning other management systems or economic conditions. If you make a faulty engine run better simply by kicking it, you start from zero again the next time it goes bad.

We have already learned a lot about selection in beef cattle. We have yet, however, to formulate "net merit" very completely. Of course, there will not be one formulation but several, for the various management schemes and economic systems that do and will exist. Most people overemphasize the instability of economic values. Our industry would be farther ahead to use imperfect selection methods that are the best we can give them rather than use imperfection as an excuse to ignore this tool.

We can surely assign economic values to feed consumption, gain as it reflects the costs associated with time and carcass composition. The value of carcass quality is more difficult because of recent and anticipated changes in grading and a lack of knowing real quality traits. Structural soundness is elusive both for its economic value and knowledge of the parameters necessary to incorporate it into a selection index. Breeders handle this trait by absolute culling levels, but what price are we paying in an overall selection scheme, especially if some apparent unsoundnesses really are not?

The economic values of cow traits need more work. Maintenance costs seem to be nearly accounted for by weight alone. Lean-fat composition of weight must have some small effect. Apparently fatter cows have less maintenance cost. We need to understand more accurately the dynamics of changing weights and degrees of finish as they relate to costs. Also, the maintenance cost situation under different kinds of grazing systems must be determined. Perhaps this could be investigated at a station like this or cooperatively with ranchers. Of course, the genetic and environmental correlations of cow traits with calf traits are an immediate need. I have suggested for some time that there is not necessarily one kind of ideal beef animal. We produce meat from species varying tremendously in size, shape and carcass characteristics. Perhaps a range of sizes of beef cattle could give similar returns on investment if a production and marketing system is geared to each.

How methodically should we try to measure heterosis and especially maternal heterosis in carefully designed experiments as breeds change and more breeds must be evaluated? Shouldn't we concentrate on guessing some potentially good 3 or 4-way crosses and getting adequate data on their overall comparative performance? I know of no area in our meat animal breeding research that cries out for regional or national planning more so than does this matter of evaluating breeds and utilizing them in crossbreeding systems.

How much energy is required to build and also to maintain fat and lean tissue other than the energy stored? Bill Flatt's work with dairy cows indicate that energy storage as fat on the animal, with later mobilization, may not be so inefficient after all. What is the nature of differences in energy utilization, if there are any other than those associated with time? To what extent are they genetic? If we would disentangle the consumption-gain-composition complex, with its circularity of cause and effect, and know the genetic and environmental parameters, we could formulate answers to many practical questions in meat animals.

Experiments where fairly large numbers of animals are individually fed, using live predictors of body composition could yield data on these questions. Groups could be fed at various levels of gain including maintenance, at various weights. In this way the differences in energy costs of maintaining and building lean and fat tissue could be ascertained.

The data suggest a positive genetic and negative environmental correlation between outside fat and marbling. If this is so, what is the explanation in terms of the mechanisms of depositing fat? Can we consistently produce lean carcasses with marbling? And the obvious counter question, do we need marbling? We must remain always cognizant of reproduction. I fear the tremendous change in carcass composition of the hog has left us with a critter that has a lower overall fitness in his environment.

One can visualize that accuracy of selection might be increased by quantitative measurements of hormones, enzymes, etc., which have high genetic correlation with desired production traits and perhaps could be measured early in life. What are the chances for drastic reductions in generation interval? Could gamete development, especially for males, be speeded up? Might we learn to enhance the maturation rate of germinal tissue, either _in vivo_ or _in vitro_, so that a bull calf might be "mated" shortly after birth, or even before? Any inroads on this would be helpful. Perhaps someday a fertilized egg can be turned into a functional sperm or egg in a few weeks, days or hours. We would also need to measure something in the

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cell on which to base selection, however, in order to turn a generation a day. Perhaps when we can do all that we will simply make steaks to order from their chemical constituents.

Lastly I would like to say that we now have more incentive to seek answers in beef cattle breeding than ever before. Our industry is at last ready for us. The direct participation of animal breeding research workers in industry action on the breeding of beef cattle, a hope and desire for most of us in the 60's, will become an accepted reality in this decade.

BEEF CATTLE RESEARCH PROGRAM FOR THE U.S. MEAT ANIMAL RESEARCH CENTER

Keith E. Gregory, Director
USMARC

The basic objective of the beef cattle research program at the U.S. Meat Animal Research Center is to make a maximum contribution to the development of new technology that can be implemented into production programs to increase the efficiency of conversion of feed and other resources available into highly palatable and nutritious beef. To make this contribution, the U.S. Meat Animal Research Center beef cattle research program must be jointly planned and cooperatively executed with other USDA and State Agricultural Experiment Station programs. Joint planning and cooperative execution of research programs are essential to the most effective use of the resources available to research interests.

To insure that research priorities are assigned in the most effective manner relating to industry problems and to the utilization of research resources, it is essential that the beef cattle industry and research interests maintain close liaison. The U.S. Meat Animal Research Center program is depending upon advisory committees to give assistance that will result in the assignment of priorities consistent with present and future problems of the beef cattle industry and with maximizing the use of research resources.

The research efforts at the U.S. Meat Animal Research Center will include swine and sheep, in addition to beef cattle. Approximately one-half of the research efforts will be on beef cattle, one-fourth with sheep and one-fourth with swine.

In addition to the Animal Science Research Division interests at the U.S. Meat Animal Research Center, other Research Divisions of ARS, USDA, that will participate in the program include Agricultural Engineering, Market Quality, Crops, Soil and Water Conservation, Entomology and Western Utilization. Also, the Production Economics Research Division, ERS, USDA, will participate in the program at the Research Center. The Nebraska Agricultural Experiment Station is an important cooperator in the U.S. Meat Animal Research Center program and it is anticipated that cooperative efforts will develop with other State Agricultural Experiment Stations.

The research program to be implemented with beef cattle at the U.S. Meat Animal Research Center will be directed toward developing new technology that can be implemented by the beef cattle industry to reduce production costs of edible beef with

maximum palatability. Attention will be given to the major factors that influence profit, including biological, physical, and managerial. This will include the full production cycle. The research program is being designed as an integrated effort involving the major scientific disciplines that relate to animal agriculture. This includes feed production, harvesting, handling, storage and utilization; animal housing and waste management; breeding and reproduction; feeding, meats technology and management systems as they relate to reproduction, growth, feed efficiency and carcass characteristics. New knowledge evolving from these programs is expected to contribute toward optimizing resource inputs in accord with economic situations and new technological developments.

While many of the specific projects will not be planned until facilities have been developed and scientific staff recruited, major problem areas of the beef cattle industry scheduled to receive attention in the research program are: (1) reproduction, (2) feed efficiency, (3) carcass merit, (4) management systems on a life cycle basis, and (5) waste management.

Reproduction:

Because of the high fixed costs associated with the maintenance of the national breeding herd of beef cattle, small increases in reproductive rate have a large effect on costs per unit of production and thus on profit margins. Research in this area will involve both sexes, and the disciplines of physiology, endocrinology, neurology, biochemistry, nutrition and genetics will be employed to increase understanding of factors that influence puberty, estrus, ovulation, conception, implantation, embryonic and fetal mortality, parturition and early postnatal mortality. This research will involve studies on male and female germ cell metabolism with the objective of developing improved procedures for preservation and storage of germ cells from both sexes. Efforts will be directed toward the development of methods of separation of male and female producing sperm cells in order to control sex of offspring.

Feed Efficiency:

Improvement in feed utilization at all stages of the life cycle by increasing utilization of nutrients from feeds, increasing efficiency of metabolic processes related to maintenance and the synthesis of edible product has great potential for reducing production costs of the beef cattle industry. The major objective in this area of work is to develop new knowledge that can be implemented into production programs to increase the amount of high quality edible product per unit of available feed resource.

The research in this area will be on a full life cycle basis and will involve the integration of the disciplines of genetics, biochemistry-nutrition, microbiology, and physiology to gain an understanding of the major factors associated with differences in efficiency of feed utilization including physical and chemical treatment of feeds, appetite, maintenance, digestion, metabolic processes and tissue deposition. This will involve the investigation of factors such as size, and genetic and environmental factors independent of size, that influence requirements for maintenance and growth of different tissues.

Techniques to be employed include the use of respiration chambers, and the effects of climatic environment (temperature, humidity, and air velocity) will be investigated by the use of appropriate chambers to control these variables.

Carcass Merit:

Unflavorable lean to fat ratios are a major problem in beef cattle carcasses. Excessive amounts of fat trim greatly increase the production costs per unit of edible product. The objective of research in this area is to develop technology that may be implemented by the beef cattle industry to reduce the amount of fat per unit of edible product while maintaining or improving the palatability of the edible product. Genetic and environmental factors that influence development of different tissues, distribution of fat and lean, and meat palatability will be investigated. Gaining an understanding of factors that influence palatability of meat and the proportion of edible meat in the carcass is the aim of this research effort.

Management Systems on a Life Cycle Basis:

The number of variables (economic, biological and physical) with which livestock producers in the future will have to cope will likely continue to increase and will probably become more complex. The alternatives available to producers to increase production efficiency will become more numerous and more dependent on specific economic and production situations. Increased research emphasis is needed to identify and quantify the major factors affecting production costs and returns to capital and management in different production and economic situations. Research in this area will relate to gaining understanding that will result in more optimum use of resources in different economic and production situations.

Waste Management:

Pollution is a national problem. The extent to which the beef cattle industry contributes to this problem has not been identified. Research in this area will relate to identification

of the nature and the magnitude of the pollution problem associated with the beef cattle industry and to the development of feasible technology for managing beef cattle waste so that the beef cattle industry is not a factor in either air or water pollution.

Germ Plasm Evaluation

A major project in progress at the U.S. Meat Animal Research Center that represents an important area of work relates to the evaluation of cattle germ plasm. This is the first cycle of a long-term research effort that is planned for this area. It is planned to include other breeds in subsequent cycles of this program. It is the intent of the program to evaluate breed differences in the full spectrum of economic traits and trait components relating to characterizing growth, feed efficiency, reproduction, maternal ability and the carcass. A basic objective of this program is to develop understanding relating to optimizing such biological factors as cow size, milk level, etc., to different feed environments and production situations. The cattle involved in the germ plasm evaluation program will contribute to studies in each of the five major problem areas discussed previously. The evaluation program is designed to consider the potential value of specific stocks in regard to their use: (1) as straightbreds, (2) in different types of breed crossing programs to utilize heterosis, and (3) for the development of new breeds.

Breed of Sire and Dam Comparisons in F_1 Crosses. 1969 through 1971 Breeding Seasons (table 1).

To initiate this program, grade Hereford and Angus females are being mated to the following sire breeds (table 1): Hereford, Angus, Jersey, South Devon, Charolais, Limousin and Simmental. These matings are being made during the 1969, 1970 and 1971 breeding seasons.

The male progeny produced from these matings will be castrated and fed out by breeding group to obtain growth, feed efficiency and carcass data.

Breed of Sire and F_1 Dam Comparisons in 3-Breed Crosses. 1971 through 1975 Breeding Seasons (table 2).

The females produced from the 1969 through 1971 matings will be retained for three calf crops, to evaluate fertility and mothering ability traits of F_1 crosses and the transmitted influence of specific "sire breeds" in 3-breed crosses (table 2). Some of these evaluations will be in confinement so that feed consumption of different breeding groups can be evaluated.

First Backcross and F_2, 1971-1975; Second Backcross and F_3, 1973-1977 (table 3).

Backcross (B_1) and F_1 inter se (i.e. F_2) matings as shown in table 3 will be produced through the second backcross and through the production of F_3's to predict proportion of heterosis retained in rotation crossbreeding and in new breed formation involving these breed crosses.

Table 1. Mating Plans for 1969*, 1970 and 1971 Breeding Seasons

Breed of dam	Breed of Sire						
	Hereford	Angus	Jersey	South Devon	Limousin	Simmental	Charolais
Hereford	X	X	X	X	X	X	X
Angus	X	X	X	X	X	X	X

* Approximately 900 calves produced from these matings in 1969.

Table 2. Mating Plans for 3-Way Crosses and Controls in the 1971 Through 1975 Breeding Seasons

Breed Group of females	Breed of Sire Hereford	Angus	Simmental	Charolais	Limousin	Other
Hereford	X[a]					
Angus		X[a]				
Angus x Hereford			X	X	X	X
Hereford x Angus			X	X	X	X
Jersey x Hereford		X	X	X	X	X
Jersey x Angus	X		X	X	X	X
South Devon x Hereford		X	X	X	X	X
South Devon x Angus	X		X	X	X	X
Limousin x Hereford		X	X	X		X
Limousin x Angus	X		X	X		X
Simmental x Hereford		X		X	X	X
Simmental x Angus	X			X	X	X
Charolais x Hereford		X	X		X	X
Charolais x Angus	X		X		X	X

[a] These are _inter se_ Hereford-Hereford and Angus-Angus matings of unselected straightbred bulls and heifers born in 1970 through 1972 from table 1. They serve as controls, for comparing F_1, F_2, F_3, 3-way, B_1 and B_2 matings made in different years since their expected genetic change is minimized and both rearing environment and age of dam will be the same as that for other breeding groups calving in the same year.

Table 3. Mating Plans for the Production of Backcrosses Through B_2 and F_2's and F_3's (1971 through 1977 Breeding Seasons)[a]

Breed group of females	Breed of Sire[b]									
	Hereford	Angus	Simmental	Charolais	AxH	HxA	SxH	SxA	CxH	CxA
Hereford	(x)[c]									
Angus		(x)[c]								
Angus x Hereford					X					
Hereford x Angus						X				
Simmental x Hereford			X				X			
Simmental x Angus			X					X		
Charolais x Hereford				X					X	
Charolais x Angus				X						X

a This table supplements table 2, to show the continuation of specific matings through the production of B_2's and F_3's, to evaluate heterosis and recombination effects.
b Bulls used in the straightbred control and in the F_2 matings are unselected samples of bulls produced in corresponding straightbred and F_1 matings of table 1.
c These are the same control matings shown in table 2.

THE ROLE OF BEEF CATTLE BREEDING RESEARCH IN CHARACTERIZING GERM PLASM RESOURCES

T. C. Cartwright

The title assigned to me implies characterizing germ plasm resources for the purpose of utilizing existing variability to increase efficiency of beef production. I believe that this is potentially fruitful research which has not been given high enough priority in the past. Research characterizing germ plasm resources yields information useful for making more judicious breed selections and for designing more efficient breeding systems. It is also useful in revealing the correct direction for selection emphasis within purebred populations and adds insight into properly setting priorities for expenditure of beef cattle breeding research funds.

Two broad objectives are suggested for research projects which involve characterizing germ plasm resources of cattle: (1) to determine the extent and nature of genetic variability of important characters within and among existing cattle populations, and (2) to determine how to best utilize this genetic variability to increase total efficiency of beef production. Characterizing germ plasm resources must include assessment of both individual and population characters. Environmental conditions of production is important knowledge and should be carefully and fully described. Economic parameters are also important. Animal breeders have given some thought to relative economic values for characters, often only cursorily, for use in constructing selection indexes. The literature indicates even less thought has been given to economic values for use in breeding and production systems. Too often these values for characters have been thought of or, at least, treated as if they were universal constants. Relative economic values appropriate for characters may vary considerably for subclasses such as:

1. Productions resources (land, capital, skill, etc.)

2. Climatic conditions (tropical, temperate, humid, arid, etc.)

3. Management system (extensive, intensive, confined, integrated, etc.)

4. Breeding system (straight, cross, specialized, generalized, etc.)

5. Market (local, contract, specialty, etc.)

6. Objective (investment, hobby, tax advantage, cash flow, etc.)

The number of subclasses, depending on the fineness of classification, may be substantial. We should strive to detect common elements of desirability of traits (trait is used here to refer to a level of a character such as high ADG or small mature size) among various subclasses, but it is clear that we should be able to respond in a logical, helpful manner (or advise others how to respond) to relatively unique situations.

Priorities must be set to limit the number of characters considered in order to increase return to research input. To aid in setting priorities cattle may be classified into two basic phases of production:

Phase I. Increasing number--the cow herd.

Phase II. Increasing weight--the steer.

Steer as used here refers to all cattle produced for slaughter rather than reproduction.

Separating these two phases is not intended to imply that they are independent in either the biologic or economic sense. The cow herd phase, which includes substantial weight increase, appears to be the more important phase. Table 1 shows about two cattle in the cow herd for each steer. U.S. cattle census figures lend substantiation to this calculation. Reports indicate about 50 million cows in the U.S. and about 25 million finished steers slaughtered each year. (The comparison using U.S. totals is inexact but should be approximately correct. Replacement heifers left out of the cow count tend to balance slaughter calves left out of the finished steer count).

Table 1. A Beef Herd Producing 100 Sale Calves Per Year[a]

Brood cows	150
Replacement heifers, yearlings	20
Replacement calves	20
Bulls	6
Subtotal	196
Sale calves	100
Total	296

[a] Assumptions included:
80% net calf crop;
13% cow replacement/year;
4% bulls.

It appears important to characterize average performance and variability of populations for characters that contribute directly and importantly to efficiency of production in Phase 1. These characters include:

Feed requirement
Age at puberty
Lifetime and annual fertility
Calving ability
Milking ability
Adaptability
Longevity
Tractability
Soundness and hardiness
Frequency of deleterious recessives

The first character, feed requirement is especially complex and interrelated with most of the other characters. In order to be meaningful, it must eventually be put in terms such as:

$$\frac{\text{Cattle output}}{\text{Feed input}}$$

Feed input includes pasture and range and cattle output includes all sales. In many cases, the most useful measure is the dollar value of input and output. The concept of a least-cost cow herd, which is similar to but not as simple as a least-cost ration for the feedlot, is implied if this ratio is maximized. (If the objective is to maximize return of beef from a given input of resources rather than to maximize profit, then other units of input and output may be more appropriate).

A knowledge of mature size and the pattern of reaching mature size are essential for evaluating feed requirements. Several, if not all, of the other characters listed, are correlated with weight-age characteristics. Relatively little is known about biological interpretation of growth curves and correlations among growth curve parameters and other characters in beef cattle. Variability of these parameters between and within breeds may be illustrated by using data from Jerseys, Angus-Brahman and Hereford-Brahman (figure 1-4 taken from Brown, 1970). The data from figure 1 illustrates differences between breed types and those from figure 2 within breed types. The later figure suggests that some of us have been considering the correlation between mature size and growth characters to be higher than it may be in some populations. These figures illustrate considerable variability within and between breeds, but they fail to separate genetic from other sources. Gain during a 140-day period leaves much to be desired and may be very misleading if taken as a criterion of efficiency of total production. At least consideration of mature size, preferably the entire growth pattern, must be included in breed characterization.

Fertility is usually considered only on a yearly basis. Variation in age at puberty and longevity may cause considerable variation in fertility considered on a lifetime basis. Neither a yearly nor a lifetime basis is separately adequate to characterize fertility, but both are important. For example, consider two herds with an average annual net fertility of 80%. If one herd calves first at 24 months of age and maintains an average of 6 years compared to another herd which calves first at 33 months and has an average age of 5 years, the fraction of heifer calves needed as replacements is 26 vs. 42. The excess of calves available for sale is 10% more in the first herd or the equivalent of about 75% increase in fertility. Also, the average annual female selection differential possible is about 5% greater even though cow generation is longer.

Longitudinal fertility data, which include longevity, are indicated for research consideration just as longitudinal growth data are indicated.

The value of milking ability is currently appreciated on a more sophisticated basis because of the advent of widespread use of dairy breeds in research beef herds. Early weaning has caught the fancy of many. For some conditions light weaning may also have advantages similar to early weaning. The inherent ability of the Hereford to limit milk production may be a valuable trait in some straightbred operations and even more valuable for operations crossbreeding with dairy breeds. Milk production, measured directly or indirectly, must be an important character. Environmental conditions should be considered more closely and described in more detail for this character than perhaps any other Phase I character.

Characters which contribute to efficiency of production in Phase II, steers, include:

Pre and postweaning rate of gain
Pre and postweaning rate of finish
Efficiency of feed utilization
Carcass cutout
Beef quality

These characters are intercorrelated. Rate of gain has some importance independent of efficiency of feed utilization because the length of time a steer is held in the feedlot (or other place) is associated with an expense independent of feed. Rate of finish has importance independent of efficiency of feed utilization principally because it is a major factor in determining grade. Efficiency of feed utilization, the real point of interest, may be divided into three primary components as functions of:

(1) Nutrient requirements for maintenance in relation to weight gain and time

(2) Composition of gain

(3) Intrinsic factors

We are reasonably well aware of the differences in maturity per unit of time or per unit of weight which are characteristic of cattle of different mature sizes. We don't always appear to use this knowledge well in practice or in research planning. Research projects involved in breed comparison should take into account the optimum weight and age for steers to be slaughtered giving consideration to slaughtering each breeding type at its "best" weight within readily marketable limits for the present and for the foreseeable future. An interesting comparison from a study by Joandet and Cartwright (1969) indicated that slaughtering steers at about 75% of optimum weight reduces efficiency of beef production by about the same amount as a 10% reduction of fertility in the cow herd.

As research workers in a distressingly slow moving field we must, of course, look ahead. The limits of weight and fatness that are often considered readily acceptable at the market place have a severely limiting influence on breeding objectives. If weight and finish are fixed, then our breeding opportunities are correspondingly limited--not fixed but restrictively limited. Does the future hold a place for a 1500 to 1600 pound steer of good or standard grade? Will the industry accept and/or adjust to such a beast if breeders make it available or demonstrate its availability?

Other than the characteristics related to rate of finish and rate of gain, the usefulness of carcass and meat characterization is not obvious. There are great opportunities for technological and managerial improvement, and I think they will continue to come rapidly. Animal breeders may do some of this research (from necessity or interest), but the useful variability appears to be largely environmental. The results may be quite useful to animal breeders but not in the sense that they are going to make genetic improvement in these characters except through weight-age manipulation.

Animal breeding research must, at least, include monitoring carcass and beef quality characters especially of recent or potential introductions. There is apparently sufficient variability in fat deposition tendencies to warrant more thorough planning and data collection. Contrasts between endomorphic and mesomorphic types such as can be observed in Angus and Charolais, for example, suggest basic differences in inherent fat deposition ability independent of stage of maturity and environment.

Characterizing steers, I believe, can be essentially reduced to weight-age and fat deposition records taking care not to overlook weight-age-finish relationships.

Recent interest in germ plasm sources largely unexploited in the U.S. has been largely restricted to cattle that have traits desirable for Phase II (i.e. sire line cattle) and perhaps for general purpose use or rotational crossing. It is clear that the trend is presently overlooking cattle well suited for Phase I (i.e. dam line cattle). Not only are new sources being overlooked, but breeders and breed associations appear to be following programs that will transform their cattle more to Phase II, and, consequently, though unintentionally, away from Phase I.

The most urgent need at present, in my opinion, is for animal breeding research to design more efficient methods of utilizing genetic variability presently available. In the process we will improve our selection of genetic source to evaluate and will better understand the changes needed in purebreds and the ramifications of selection programs for purebreds. Also, the need for pragmatic research results to help sustain the source of our funds adds a compelling incentive.

The separation of Phase I and Phase II emphasizes the divergence of traits desirable in the cow herd and in steers. The most feasible solution appears to be designing breeding and production systems which tend to bypass the undesirable and utilize the desirable traits. Such methods as linear programming offer a good starting point for evaluating breeding systems designed for various management and market situations. Investigation of several limited systems (Long and Fitzhugh, 1969) has intrigued us to refine techniques and investigate further. To illustrate this approach a linear program is used which is simplified by considering a confinement system of beef cattle production (Cows *et al.* kept in a feedlot) so that accounting for value, consumption and utilization of nutrients requires fewer unrealistic assumptions. The systems, input data, etc. and results are summarized below. The "solutions" illustrate, among other things, that the balancing effects between Phase I and Phase II of three contrasting breeding systems and types of cattle are of vital importance to animal breeders. Isolated, single character characterization is not sufficient and may even lead to procedures which reduce rather than increase efficiency.

A point that I have attempted to develop is that data on nutrient requirements, levels of production, value of product and other production factors are often either not available or not applicable as input information to test efficiency of breeds or breeding systems for sets of environmental conditions. A valuable contribution to beef cattle breeding that I believe

should receive high priority, would be filling this information shortage so that more sophisticated, adequate methods of evaluation can be employed. Animal breeders will probably have to be responsible for collecting a good portion of the resource data he needs, but if motivated and informed, research workers in other fields could and probably would aid even more than they have in the past in compilating suitable data. The responsibility for design, especially to include controls or other bases for meaningful comparisons, should rest mainly with the animal breeder.

Without belaboring the necessity for animal breeding research to direct its objects toward the future, characterizing germ plasm resources should be done with the awareness that our research objectives may be required to, or well advised to, include evaluation of the effect of application of the research results on broad based considerations such as the return of food value per unit of natural resource invested or the effect on the gross state product as well as individual profit.

References

Brown, J. 1970. The use of nonlinear models to describe weight-age relationships in cattle. Ph.D. dissertation. Texas A & M University, College Station.

Long, C. R. and H. A. Fitzhugh, Jr. 1969. Comparison of alternative beef breeding programs. J. Anim. Sci. 29:109.

Joandet, G. E. and T. C. Cartwright. 1969. Estimation of efficiency of beef production. J. Anim. Sci. 29:862.

An Illustration Prepared for the Joint Meeting of the Technical Committees of NC-1, S-10 and WRCC-1*

Breeding Systems and Input Data

	System I Brahman-Hereford cows. Crisscross matings to produce replacements. Charolais X B-H♀ to produce sale calves.	System II Angus-Jersey cows. Crisscross matings to produce replacements. Charolais X A-J♀ to produce sale calves.	System III P.B. Angus
Mature weight, ♀	517 kg	370 kg	430 kg
Annual replacements	13%	15%	16%
Age at first calf	27 mo	23 mo	25 mo
Milk yield, 180 day	1000 kg	1000 kg	675 kg
Weaned, %	84%	84%	81%
180 day weaning weight:			
Replacement[a]	195 kg	172 kg	174 kg
Sale[b]	211 kg	200 kg	174 kg
Feedlot ADG[c]			
Replacement♂[a]	1.043 kg	0.862 kg	
Sale♂[b]	1.179 kg	1.088 kg	0.95 kg
Sale♀[b]	1.088 kg	0.998 kg	0.82 kg.
Sale price, kg.			
Weaned	$.70	$.70	$.70
Backgrounded	.68	.68	.68
Fed	.60	.60	.60
Cull cow	.33	.33	.33

a Crisscross H-B, crisscross A-J, or purebred Angus.
b Charolais sire X H-B, Charolais sire X A-J or purebred Angus.
c ♂=steer only, ♀=heifer or cow.

* Prepared by Charles R. Long, in consultation with T. C. Cartwright and C. F. Lard, Texas A & M University, by use of linear program methods.

Linear Programming methods were used to obtain an optimal solution imposing the following assumptions, constraints and procedures:

1. All nutrients were obtained from least cost rations (computed in a separate program) of feed readily available and widely used in feedlots in Texas. Conclusions drawn from this illustration are likely to be nearer the truth if all production is assumed to be in confinement (feedlot).

2. Only nutrient costs were considered.

3. The production and market values from page 1 were used.

4. Nutrient requirements were obtained from N.R.C. 1970 Nutrient Requirements of Domestic Animals, No. 4. Nutrient Requirements of Beef Cattle. National Research Council, Washington, D.C.

5. A fixed amount of capital was available to purchase nutrients. It was set at (adjusted to) $16,705.65 so that a cow herd of 100 would be maintained for System II.

6. Since capital was fixed, gross return was maximized.

The table below gives the optimal solutions. When the three breeding systems are included, System II only is included in the optimal solution. In order to obtain comparisons, an L. P. using only System I was run and then on L.P. for only System III was run. In order to simplify comparisons, numbers and corresponding production values were adjusted to the equivalent of a 100 cow herd for the optimal solution (System II).

Optimal Solutions for Three Combinations of Breeding Systems

	System I** B-H Crisscross, C X B-H♀	System II* A-J Crisscross, C X A-J♀	System III** Purebred Angus
Number of cows	74	100	93
Number of sale calves:	53	69	60
Weaned, sold	-	-	-
Backgrounded, sold	-	15♂[a]	-
Back., fed, sold	53 ♀♂[a,b]	54♀♂[b]	60♀♂[a,b]
Number cows culled, sold	10	15	15
Weight of calves and culls, kg.:			
Weaned, sold	-	-	-
Backgrounded, sold	-	3030	-
Back., fed, sold	29289	26840	24799
Cows culled, sold	5005	5550	6388
Return, gross	$19,471.44	$20,307.22	$17,271.19
Return over nutrient cost	$2,765.79	$3,601.57	$565.54
Return, % of optimal sol.	77%	100%	16%

[a] Crisscross H-B, crisscross A-J or purebred Angus.
[b] Charolais sire X H-B; Charolais sire X A-J or purebred Angus.
* Optimal solution when all three breeding systems are included.
** Optimal solution when either System I or System III considered singly.

Stability of Optimal Solution with Respect to Cattle Price Changes--

Under the conditions given, using least cost rations based on current prevailing prices, the system of breeding which resulted in greatest return to investment in feed was System II. The ranges through which prices of cattle may be varied (one at a time) without causing a change in the solution are:

Weaned calf price:	$.0000/kg. to $.7126/kg
Backgrounded calf price:	$.6692/kg to $.7625/kg
Fed steer or heifer price:	$.5387/kg to $.6163/kg
Cull cow price:	$.1729/kg to $.8658/kg

Number of cows and number of calves sold after weaning, backgrounding and feeding in the optimal solution at various critical price levels.[a]

Prices $/kg						No. of calves sold at weaning			No. of calves Bak. & sold			No. of calves Bak., fed & sold		
Wean calf	Bak. calf	Fed calf	Cull cow	System	No. of cows	Repl bred ♂	Charo cross ♂	Charo cross ♀	Repl bred ♂	Charo cross ♂	Charo cross ♀	Repl bred ♂	Charo cross ♂	Charo cross ♀
0.0	.68	.60	.33	II	100	-	-	-	15	-	-	-	27	27
.7126	.68	.60	.33	II	101	15	-	-	-	-	-	-	27	27
.8009	.68	.60	.33	II	121	18	-	33	-	-	-	-	33	-
.8523	.68	.60	.33	II	155	23	42	42	-	-	-	-	-	-
1.00	.68	.60	.33	II	155	23	42	42	-	-	-	-	-	-
.70	0.0	.60	.33	II	101	15	-	-	-	-	-	-	27	27
.70	.6692	.60	.33	II	100	-	-	-	15	-	-	-	27	27
.70	.7625	.60	.33	II	116	-	-	-	17	-	31	-	31	-
.70	.8075	.60	.33	II	144	-	-	-	22	39	39	-	-	-
.70	1.00	.60	.33	II	144	-	-	-	22	39	39	-	-	-
.70	.68	0.0	.33	II	144	-	-	-	22	39	39	-	-	-
.70	.68	.5109	.33	II	116	-	-	-	17	-	31	-	31	-
.70	.68	.5387	.33	II	100	-	-	-	15	-	-	-	27	27
.70	.68	.6163	.33	II	93	-	-	-	-	-	-	14	25	25
.70	.68	1.00	.33	II	93	-	-	-	-	-	-	14	25	25
.70	.68	.60	0.0	II	93	-	-	-	-	-	-	14	25	25
.70	.68	.60	.1729	II	100	-	-	-	15	-	-	-	27	27
.70	.68	.60	.8658	II	101	15	-	-	-	-	-	-	27	27
.70	.68	.60	.9829	II	121	18	-	33	-	-	-	-	33	-
.70	.68	.60	1.00	II	121	18	-	33	-	-	-	-	33	-

a Prices were varied from 0.0 to $1.00.
The three breeding systems were considered but only System II entered the solution.
Only points of major change are indicated.

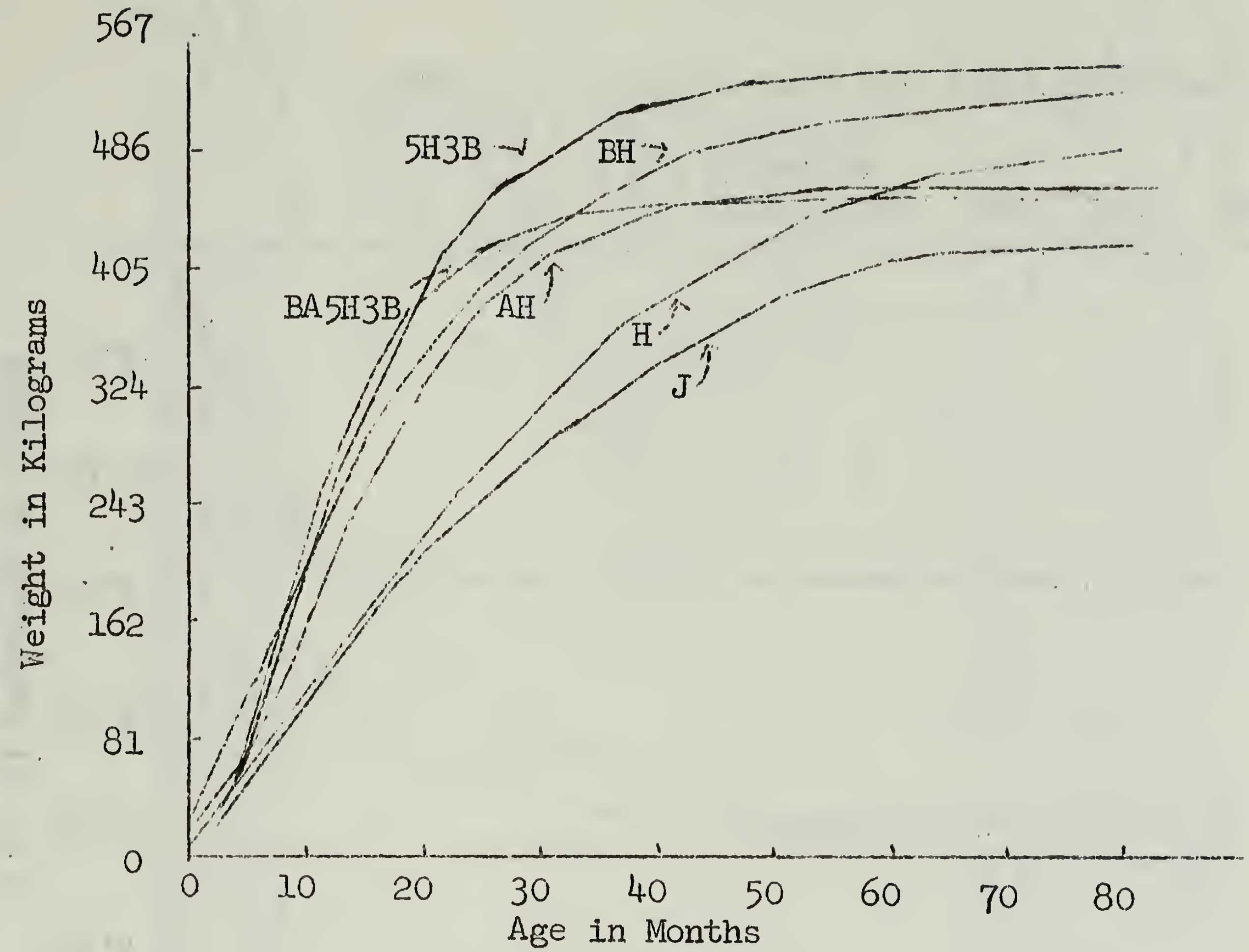


Figure 1. Mean Growth Curves for Six Breed Groups

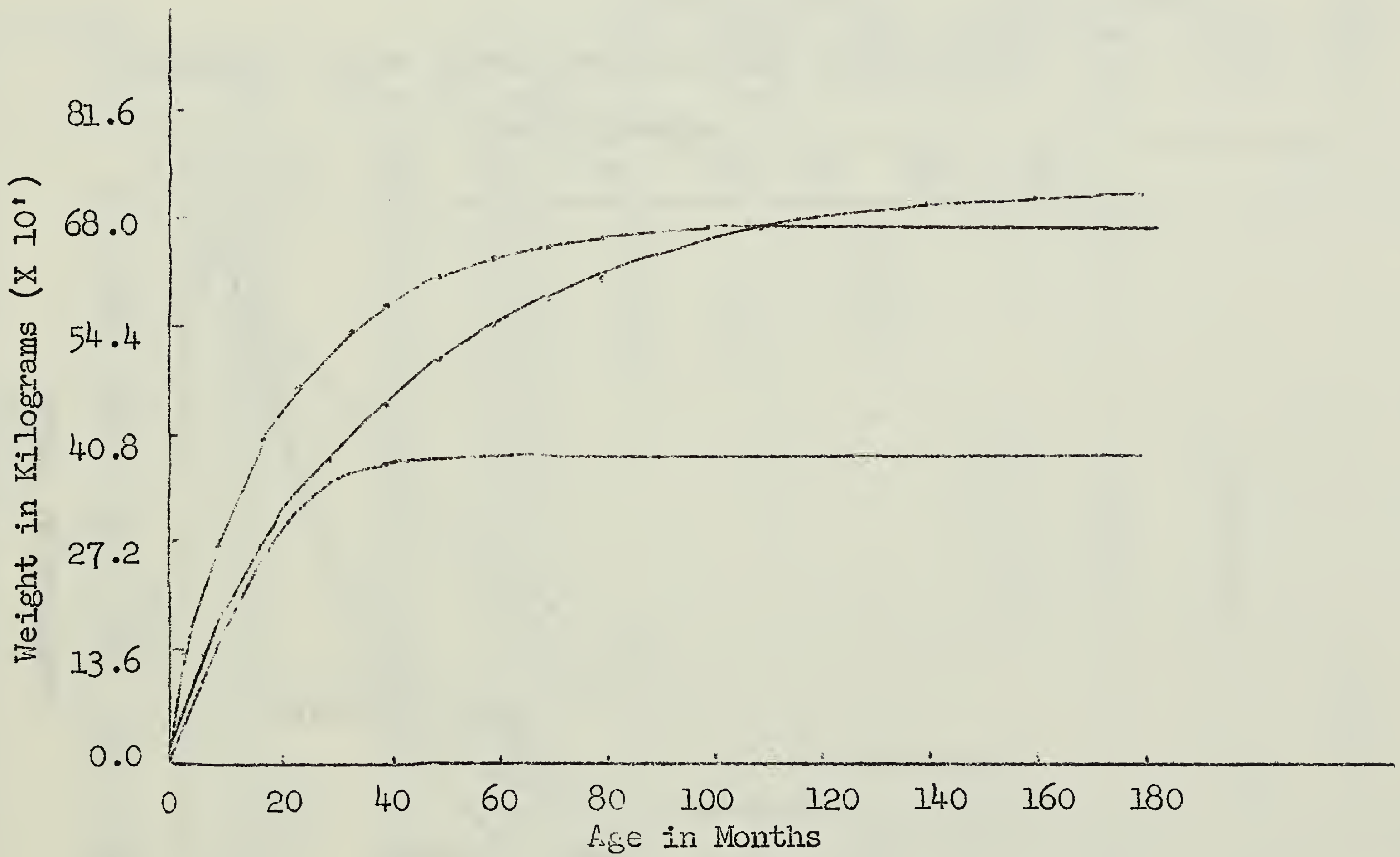


Figure 2. Growth curves for 3 B-H Individuals

TEXAS-ARGENTINA COOPERATIVE EVALUATION PROGRAMS

T. C. Cartwright

The Texas Agricultural Experiment Station (TAES) has a cooperative project with Instituto Nacional Tecnologia Agropecuaria (INTA), the federal agricultural research agency for Argentina, entitled "Beef Production Potential of Exotic Breeds and Their Crosses Under Extensive Pasture Conditions" and numbered TAES S-1760. This cooperative project is sponsored only by INTA and TAES. INTA has the responsibility for collecting data and TAES has the responsibility for data processing and analysis. Procedures and design are controlled by INTA and TAES makes consultation available.

The project is designed to test the suitability of various breeds for beef production in Argentina. Environmental and management condition are probably more similar to those in the U.S. than any other one country, other than Canada. Emphasis is being placed on use of semen from Continental European and Argentina dairy breeds. Growth and carcass data have been collected, punched and transmitted to Texas for analysis for the breeds and crosses listed below (♂ x ♀):

Fleckvieh (F) x Angus (A)
Gelvieh x Angus
Limousin (L) x Angus
Santa Gertrudis x Angus
Brahman x Angus
Holando Argentino x Angus
Charolais x Charolais (C)
Hereford x Hereford
Angus x Angus
Angus x A-C
Charolais x A-C
A-C x A-C
Fleckvieh x A-F
Limousin x A-L

Calves sired by Italian breeds; Chianina, Piedmont, Romagnola; have been weaned. Their weights, appearance and uniqueness have created considerable interest. Other breeds will be incorporated in the project as time and facilities permit.

EVALUATION AND UTILIZATION OF BREED DIFFERENCES

G. E. Dickerson

As I remember previous joint meetings of the Southern, Western and North Central Technical Committees on beef cattle breeding, there have been definite changes in emphasis. In 1949 at Miles City we were giving much attention to the development of inbred lines of cattle with selection. In 1960 at Stillwater our attention had shifted more to selection without inbreeding and the use of control procedures to measure selection response experimentally. As we meet in 1970 much attention is being given to evaluation and utilization of breed differences.

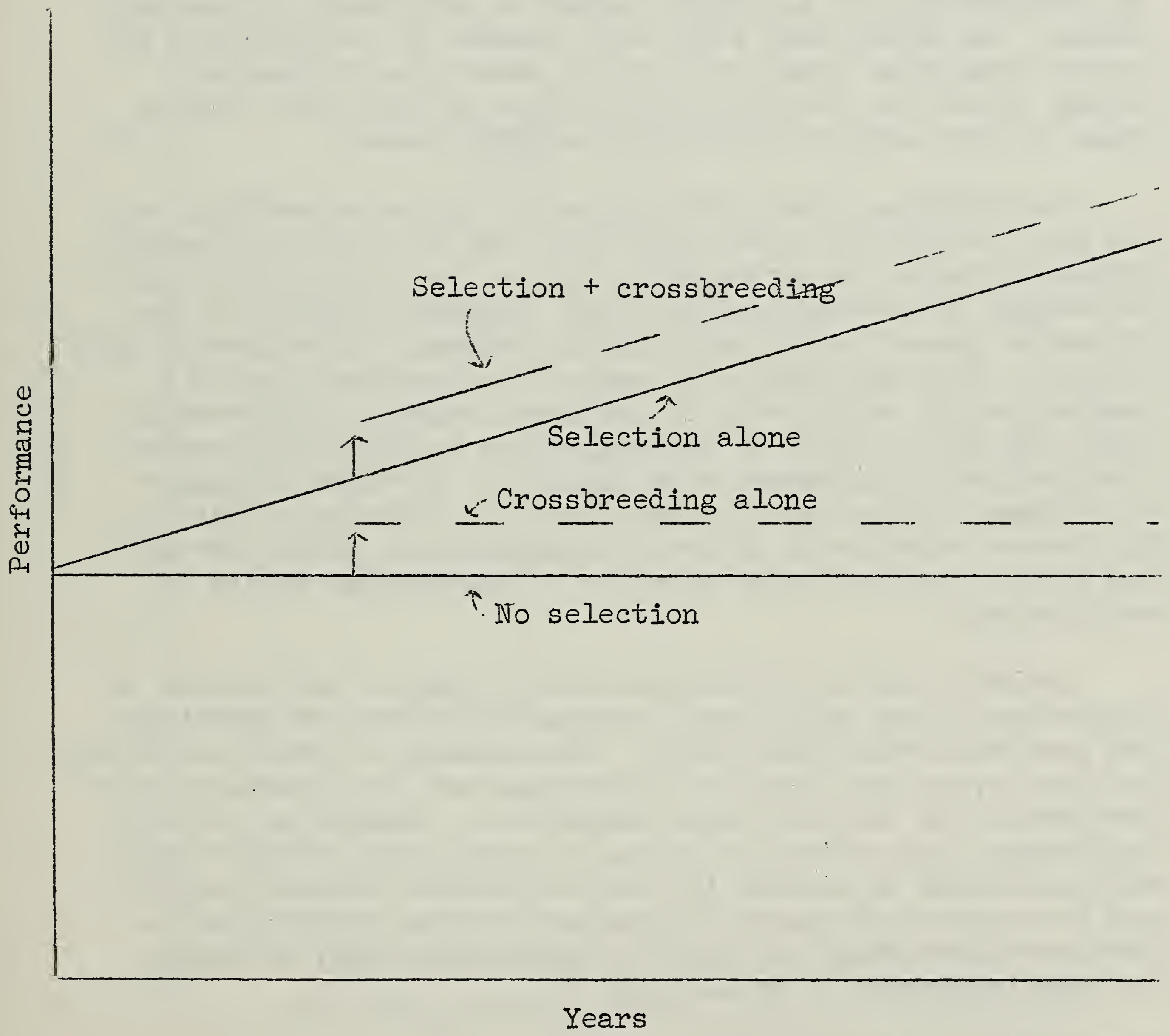
Why focus on breed and cross differences?

Breed differences are an important part of the total genetic variation available to produce genetic improvement. Unlike the genetic variation available within breeds, differences between breeds can be quickly exploited. If breed differences are estimated accurately, average heritability realized in utilizing such differences is 100% ± errors of sampling in particular applications. Genetic variation among existing breeds also provides great flexibility in producing quickly the combinations of individual and maternal genotypes best adapted to a particular management system and market requirement. Also, some crossbreeding systems permit more optimum combination of individual and maternal genetic components of performance than can be obtained within a single interbreeding population. We should remember, however, that gains from crossbreeding and selection among breeds are a one-shot affair. They are the "frosting on the cake." Continued improvement requires selection within the parent breeds or within new "synthetic" breeds (figure 1).

Composition of population differences.

Compared with a hypothetical population representing all possible crosses among existing breeds of cattle, our present breeds can be thought of as mildly inbred lines which differ from each other in (a) mean gene frequencies due to divergence in selection for particular characteristics and for adaptation to particular environments and also to random drift in gene frequencies due to limited population size, (b) average heterozygosity relative to each other and relative to hypothetical population of all possible crossbreds. Thus, breed differences include not only the average effects of genes in crosses but also deviations due to dominance and to epistatic gene effects which are influenced by the level of heterozygosity or inbreeding. Except for the chromosome controlling sexual dimorphism, male

Figure 1


Selection + crossbreeding
Selection alone
Crossbreeding alone
No selection
Performance
Years

and female parents are required to have the same average genotypes. Figure 2 shows mean level of performance changing in a curvilinear fashion with increased inbreeding, relative to the mean for all possible crossbreds. This curvilinearity is based on the general assumption that the detrimental effect of losing an additional useful gene effect becomes more serious as the total number of useful gene effects present in the system declines with inbreeding. There is a fair amount of experimental evidence supporting this assumption, in addition to its theoretical reasonableness. If true, it may help explain why application of reciprocal recurrent selection to increase cross performance has not been as rapidly successful as would have been expected if performance were linearly related to percentage of heterozygosity. In actual data with large animals it is difficult to detect deviations from linearity in inbreeding depression, partly because of selective elimination of the poorer inbred lines as the level of inbreeding becomes greater.

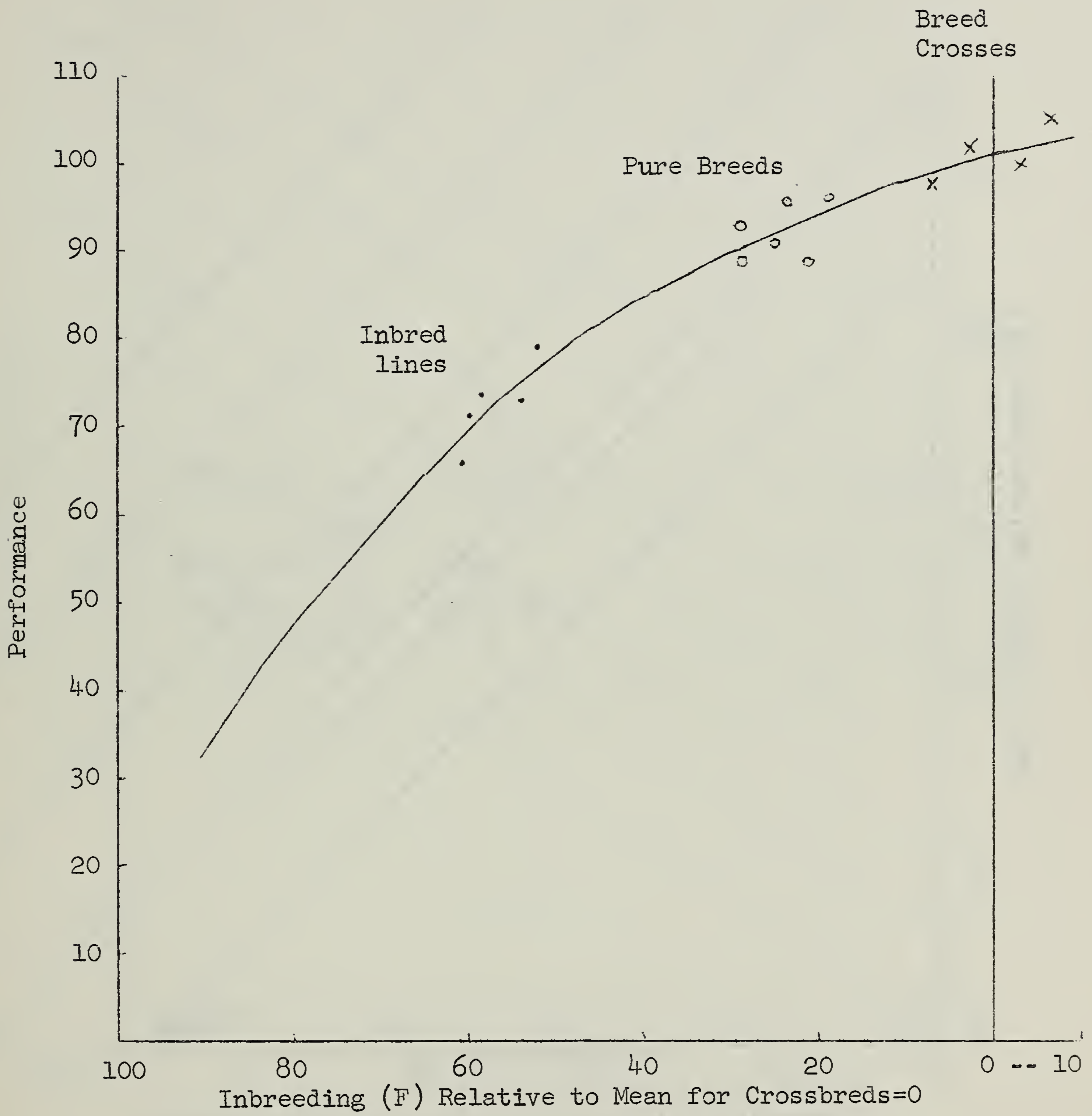
In utilizing breed differences through crossbreeding, we not only select the breeds which have the best average transmitted influence on performance, but we also utilize the higher percentage of heterozygosity of the crossbred progeny or the crossbred parent to activate useful dominance and epistatic gene effects. Thus improved performance from crossbreeding is a combination of superiority in the mean frequency of favorable genes and in the level of heterozygosity in particular cross combinations as illustrated in figure 3. As shown in figure 4, optimum utilization of breeds involves choosing breeds or F_1 crosses superior in maternal performance as female parents and those relatively more superior in postweaning traits as male parents.

Probably the most important single type of information in evaluating breeds is the mean transmitted effect on individual and maternal cross performance. This measure of breed differences has less error from level of inbreeding and from epistasis than performance of the purebreeds themselves. Ranking in purebred performance, of course, is useful in predicting average transmitted effects in crosses but the correlation between purebred and crossbred performance is limited by breed differences in level of inbreeding, in epistatic interaction and, of course, by sampling errors of estimation.

Alternatives in breed utilization.

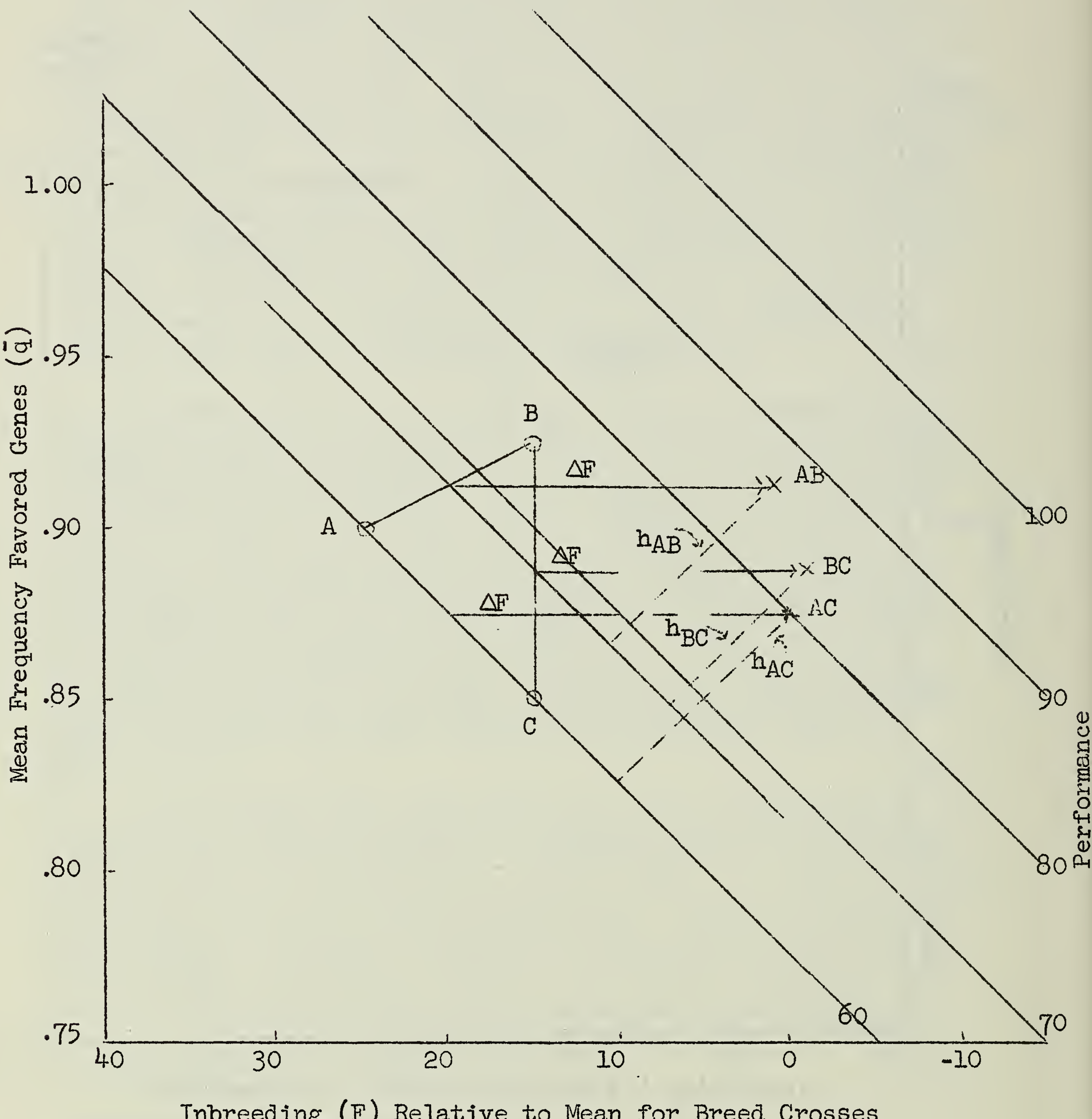
Expansion of superior breeds and corresponding reduction of less well adapted breeds has been a widely used method of breed utilization. The method most commonly used, of course, has been "grading up" through the more adapted breeds. Four or five decades ago our counter-parts were busily engaged in encouraging this type of genetic improvement of the livestock

Figure 2



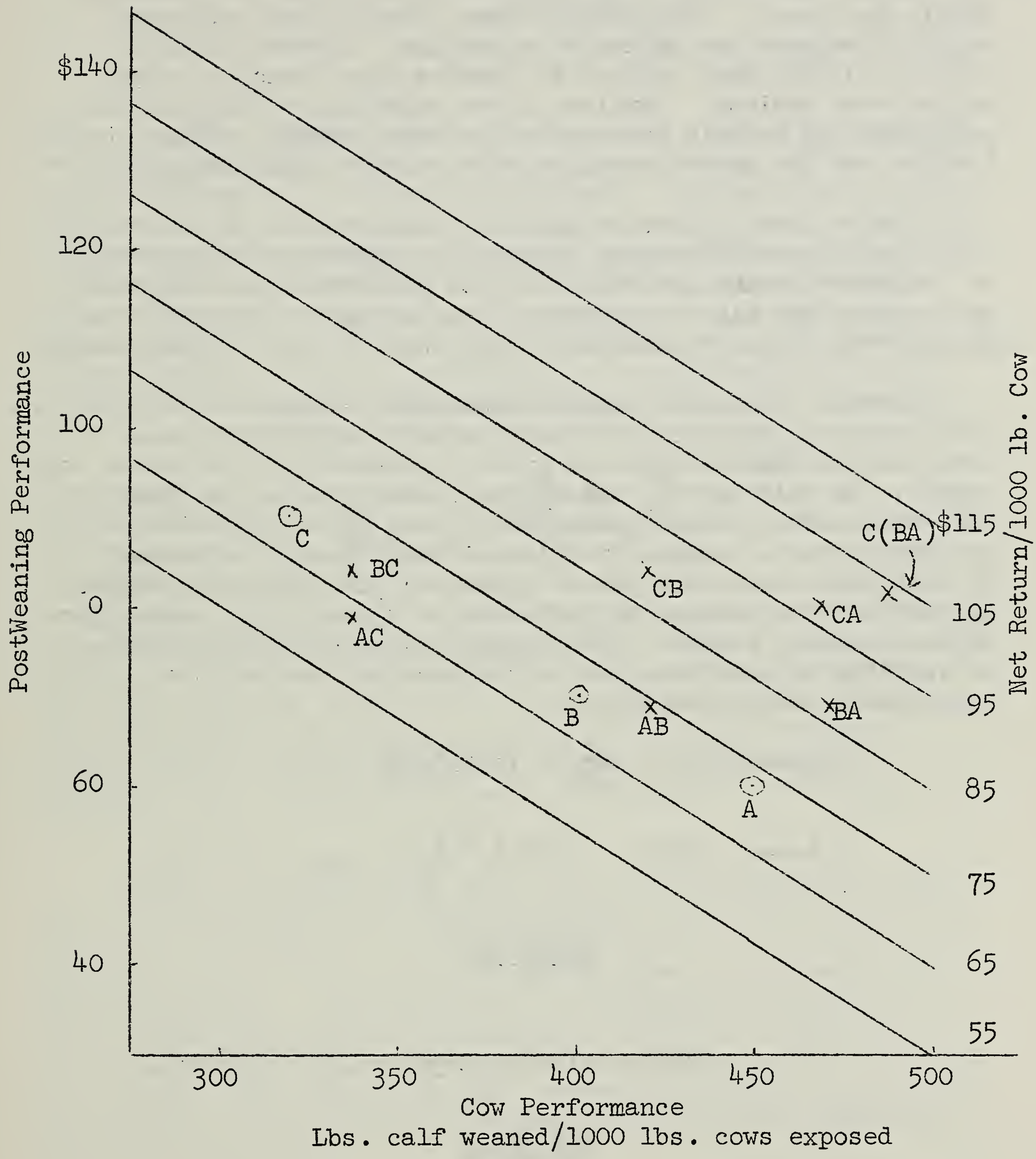
Breed
Crosses
Pure Breeds
Inbred
lines
110
100
90
80
70
60
50
40
30
20
10
Performance
100
80
60
40
20
0 -- 10
Inbreeding (F) Relative to Mean for Crossbreds=0

Figure 3



1.00
.95
.90
.85
.80
.75
Mean Frequency Favored Genes ($\bar{q}$)
B
A
C
ΔF
ΔF
ΔF
AB
BC
AC
h_{AB}
h_{BC}
h_{AC}
100
90
80
70
60
Performance
40
30
20
10
0
-10
Inbreeding (F) Relative to Mean for Breed Crosses

Figure 4



PostWeaning Performance
$140
120
100
0
60
40
Net Return/1000 lb. Cow
$115
105
95
85
75
65
55
C
BC
AC
CB
CA
C(BA)
BA
B
AB
A
300
350
400
450
500
Cow Performance
Lbs. calf weaned/1000 lbs. cows exposed

population. Grading up or backcrossing to the superior breeds is quite efficient because it utilizes the reproductive capacity of the breeds which are being displaced. Another alternative is simply expanding the superior breeds by doing less culling within the breed. This method seems clearly less efficient since it reduces the amount of selection. However, if the relaxed culling only applies to females this advantage might not be very serious. Studies of the expansion of the Friesian population in Britain have indicated that reduced culling of females was the method actually used, rather than grading up.

Some system of crossbreeding is likely to be effective in utilizing breed differences because the greater heterozygosity of crossbreds means heterosis in both individual and maternal performance and also may permit exploitation of breed differences in maternal versus transmitted individual effects on performance.

Specific crossbred combinations make maximum use of breed differences in male versus female parents superiority, but their use is limited when the rate of reproduction is low as in cattle. We will use h^I_{AB} and h^M_{AB} to indicate heterosis for individual and maternal traits and g^I_A and g^M_A to symbolize breeding values. Losses of epistatic superiority maintained by selection within the parent purebreed through recombination in gametes from crosses is indicated as r^I_{ab} and r^M_{ab}. Subscripts indicate parent breeds. Then compare the expected performance of specific crosses relative to the purebred mean of the constituent breeds as follows:

$$2 \text{ Breed } (F_1) = +h^I_{AB} + 1/2(g^M_B - g^M_A)$$

$$3 \text{ Breed, } C(AB) = +1/2(h^I_{CA} + h^I_{CB}) + h_{AB} + 1/4\, r^I_{ab} + \frac{g^M_A + g^M_B - 2g^M_C}{4}$$

$$AB(C) = +1/2(h^I_{AC} + h^I_{BC}) + h^P_{AB} + 1/4\, r^I_{ab} + \frac{2g^M_C - g^M_A - g^M_B}{4}$$

$$4\text{ Breed }(AB)(CD) = 1/4(h^{I}_{AC}+h^{I}_{AD}+h^{I}_{BC}+h^{I}_{BD}) + h^{P}_{AB} + h^{M}_{CD} + 1/4(g^{M}_{C}+g^{M}_{D}-g^{M}_{A}-g^{M}_{B}) + 1/4(r^{I}_{ab}+r^{I}_{cd})$$
$$= \bar{h}^{I} + \bar{h}^{P} + \bar{h}^{M} + (1/2)\bar{\Delta}g^{M} + (1/2)\bar{r}^{I}$$

Thus, in first crosses or two-breed crosses, one gains the full heterosis for individual performance and one-half of the pure breed difference in maternal performance. Essentially maximum utilization of heterosis and transmitted differences in maternal performance is obtained in the specific three-breed cross of a superior male breed with the F_1 cross of two superior female breeds. Note that the full gain in heterosis for both individual and maternal effects is obtained and only 1/4 approximately of the maximum possible probability of recombination effects between chromosomes of different breeds is expected. The three breed cross of F_1 sires on purebred dam utilizes heterosis in male reproductive performance and reverses the difference in breeding value for maternal performance. The four breed cross utilizes fully heterosis in individual, paternal and maternal performance and any difference in breeding value for maternal performance between the two lines on the female side and those on the male side. However, there is twice as much opportunity for recombination effects in the gametes produced producing the progeny. In recent times corn breeders have moved away from four breed crosses and toward three breed and single crosses for commercial production in order to reduce recombination effects and to utilize more elite lines. We have ignored breeding value differences in male reproductive performance (g^P).

Rotation crossbreeding utilizing only purebred males has the strong advantage of utilizing a high proportion of maximum potential heterozygosity with recombination effects kept relatively low because only the female parent produces recombination gametes. However there is a disadvantage that the same average genotype must be accepted for both individual and paternal performance except for that controlled by the sex chromosome. Also, there is less uniformity between generations, the progeny or the dam being determined half by the immediate purebred sire breed.

$$2\text{ Breed} = +(2/3)(\bar{h}^{I}+\bar{h}^{M}) + (2/9)(\bar{r}^{I}+\bar{r}^{M})$$

$$3\text{ Breed} = +(6/7)(\bar{h}^{I}+\bar{h}^{M}) + (2/7)(\bar{r}^{I}+\bar{r}^{M})$$

$$4\text{ Breed} = +(14/15)(\bar{h}^{I}+\bar{h}^{M}) + (17/45)(\bar{r}^{I}+\bar{r}^{M})$$

Some of the advantages of specific and rotation crossbreeding can be combined by using males from the sire breed on females produced by rotation crossbreeding among breeds chosen for more largely maternal traits.

$$C♂ \times 2 \text{ breed rotation } ♀ \text{ (AB)} = \bar{h}^{I}_{C} + (2/3)h^{M}_{AB} + (2/9)(r^{I}+r^{M})_{AB} + \frac{g^{M}_{A}+g^{M}_{B}-2g^{M}_{C}}{4}.$$

In this case all of the individual heterosis and a large part of the maternal heterosis can be utilized with relatively little handicap from recombination effects and making considerable use of breed differences in maternal performance.

New "synthetic" breeds offer the same opportunity as rotation crossbreeding for retaining most of the individual and maternal heterosis which could be obtained in an F_1 individual.

$$F_3 \text{ of n Breeds} = \frac{(n-1)}{n}(h^{I}+h^{M}+h^{P}+r^{I}+r^{M}+r^{P})$$

However, in synthetic breeds the base population is subject to recombination effects--if these are important--which are directly proportional to the expected level of heterozygosity. Also in synthetic breeds it is not possible to use different genotypes for the male and female parent. It is commonly assumed that rate of response to selection would be greater in a breed beginning with a crossbred base than in the parental pure breeds themselves. However, if the number of genes affecting the various components of performance involved are quite large, then the change in additive genetic variance would be rather small. In his experiments selecting for postweaning gain in mice, Comstock has now concluded that response has plateaued since about generation 43. He has now estimated the number of loci which have contributed to the response obtained to this point as being in the order of 200 to 300. This is for only one trait. Surely when both individual and maternal traits are considered, the number of loci likely to be involved is very large and we probably should not expect any great change in the effectiveness of within breed selection from beginning with a crossbred foundation. The main advantage is likely to be in correcting the cumulated inbreeding effects present in the constituent pure breeds. Here it is very important to avoid the mistakes of the past by maintaining large enough effective population size so that the initial advantage of increased heterozygosity is not squandered by early re-inbreeding of the new breed.

It is apparent that the relative magnitude of heterosis recombination effects and of breeding values for individual and maternal performance determine the most advantageous method of utilizing genetic differences among breeds. The larger the individual and maternal heterosis is, the more advantage crossbreeding or synthetic breeds have over present pure breeds.

The larger the breed difference in maternal versus individual performance, the more important it is to use some type of specific cross rather than rotation, crossbreeding, or development of new synthetic breeds. If recombination loss of epistatic superiority maintained in the existing pure breeds by selection is important, then crossbreeding has a distinct advantage over synthetic breeds as a means of utilizing existing breed differences. Of course, the lower the rate of reproduction, the more difficult specific crossbreeding systems are and the more advantage there is in rotation crossbreeding or in synthetic breeds.

Estimation of Parameters.

Evidence concerning breed differences is obtained both from the pure breeds themselves, of course, and from crossbreeding. Even though confused by differences in accumulated inbreeding or epistatic gene effects, breed differences in purebred performance certainly are indicative of major differences to be found when the breeds are used in crossing. Thus, preliminary screening of breeds with regard to individual and maternal traits certainly can be done on the basis of comparisons of purebred performance.

In crossbreeding evaluation the main effects of breed of sire on both individual and maternal performance of F_1 progeny is probably the most useful single kind of information to be obtained. Here we can utilize the general principle of factorial experimental design so that the precision of comparison of any two breeds of sire is determined primarily by the total numbers of progeny by breed of sire, and not by numbers in any specific cross from that breed of sire. This is true unless interaction between breed of sire and breed of dam or specific combining ability is important. If the purebreds are left out of the analysis, such interaction is very unlikely to be significant with the levels of inbreeding to be found in domestic breeds of cattle. Thus, as one increases the number of breeds being evaluated in the same experiment the required numbers of observation per breed of sire do not increase and total numbers increase in direct proportion to the number of breeds of sire evaluated, not in proportion to $n(n-1)$ different crosses, counting reciprocals. This means that one can include more breeds in a given testing program without as prohibitive increases in total size of the experiment. In figure 5 the standard error of a mean difference between two breeds of sire is shown as affected by the number of sires per breed of sire and by total numbers of progeny per breed of sire. The upper (dashed) lines refer to maternal performance for the heritability of 20% and coefficient of variation 20% and three records per female. The lower lines refer to a trait such as weaning weight with 30% heritability and a 10% coefficient of

variation and a single observation per individual. Notice in both cases that increasing total numbers of progeny per breed of sire reduces the standard error of the mean difference very slowly as compared to increasing number of sire progenies per breed. Note that reduction of the standard error for the mean difference to 2%, which corresponds to 1:1 chance of detecting a 5% difference with a probability equal to or less than .01, would require twenty sire progenies of eight females each for maternal performance but only about five sires with eight progeny each for individual performance. It is clear that adequate and representative sampling of sires from the breeds under test is of critical importance and also that pooling of data from different stations will be required if the parameters are to be estimated with a desired degree of precision, particularly for some of the more highly variable and less heritable traits.

In the two-way table of F_1 crosses, breed of dam effects, of course, contain both the transmitted and the direct maternal influences on the progeny including epistatic and inbreeding level effects. Estimation of maternal effects alone involves subtracting the estimated breed of sire effect from breed of dam effect. This, of course, is the variance of difference between two differences and would have a variance which would be the sum of the two variances for the separate mean differences.

Estimates of the parameters which influence choice of mating system are somewhat more complex. Heterosis of individual performance, of course, is estimated directly by comparing F_1 with parental mean performance. Maternal heterosis plus 1/4 of the potential maximum recombination effects is estimated by the superiority of three-way crosses over the constituent F_1 average. Special designs, of course, can be used to estimate maternal heterosis without confusion with recombination effects as Willham has pointed out. In fact, comparison of the reciprocal three-way crosses will be an estimate of maternal heterosis alone, ignoring sex linked differences (if $h^P = 0$). Estimation of recombination effects or of proportion of heterosis retained in advance generations, requires comparison of the F_3 generation or second generation of inter se mating with the other types of crosses. This will usually involve comparison of crosses not produced in the same year and thus requires a control population from which each kind of cross can be deviated in order to make between year comparisons of different kinds of crosses.

$$\bar{F}_1 - \bar{P} = h^I$$

$$C(AB),\ (3\text{-way}-\bar{F}_1) = h^M + 1/4\ r^I$$

$$AB(C),\ (3\text{-way}-\bar{F}_1) = 1/4\ r^I$$

$$C(AB),\ (3\text{-way}-\bar{F}_3) = 1/2\ (h^I + h^M) - 1/4\ r^I - 1/2\ r^M$$

Estimation of expected standard errors is more complex and the standard errors are not the same for different parameters but again it is reasonably certain that combining of evidence from different experiments will be necessary to achieve reasonable precision in the estimates. When purebred populations of the breeds being evaluated are included in the experiment the design for estimating both average breed of sire effects and the heterosis recombination parameters is really straight forward and does not involve back crosses. However, when some of the breeds evaluated are imported and only sires are obtained, several breeds may be used as tester or reference breeds for evaluating them in comparison with the breeds represented only by sires (figures 6 and 7). In the latter case back crosses to the imported breed will be required to approximate the parameters of the imported pure breed itself.

<u>Steps in evaluating breeds and methods</u>.

As an outline summary one might follow the steps indicated below in evaluating some of the more promising breeds in a particular class of livestock.

A. Define objectives

1. Relative economic importance of traits
2. Consumer preferences--market
3. Sources of variable costs
4. Probable future management systems

B. Select management conditions which:

1. Minimize production costs
2. Maximize product acceptance

C. Select breeds and method of use

1. Screen breeds--existing information
2. Assemble promising breeds
    a. Adequate sample
    b. Quarantine problems
    c. Sires only?

3. Compare pure breeds under defined objectives and conditions

   a. Classify as "sire" or "dam" breeds for crossing

4. Compare F_1's and P_1's for best breeds

   a. Separate transmitted, maternal effects

   b. Choose sire-dam breeds

5. Compare 3-breed crosses

   2 or 3 sire breeds x all F_1 ♀ of 6-8 breeds.

6. Produce F_2, F_3 for only crosses of best 3 or 4 breeds

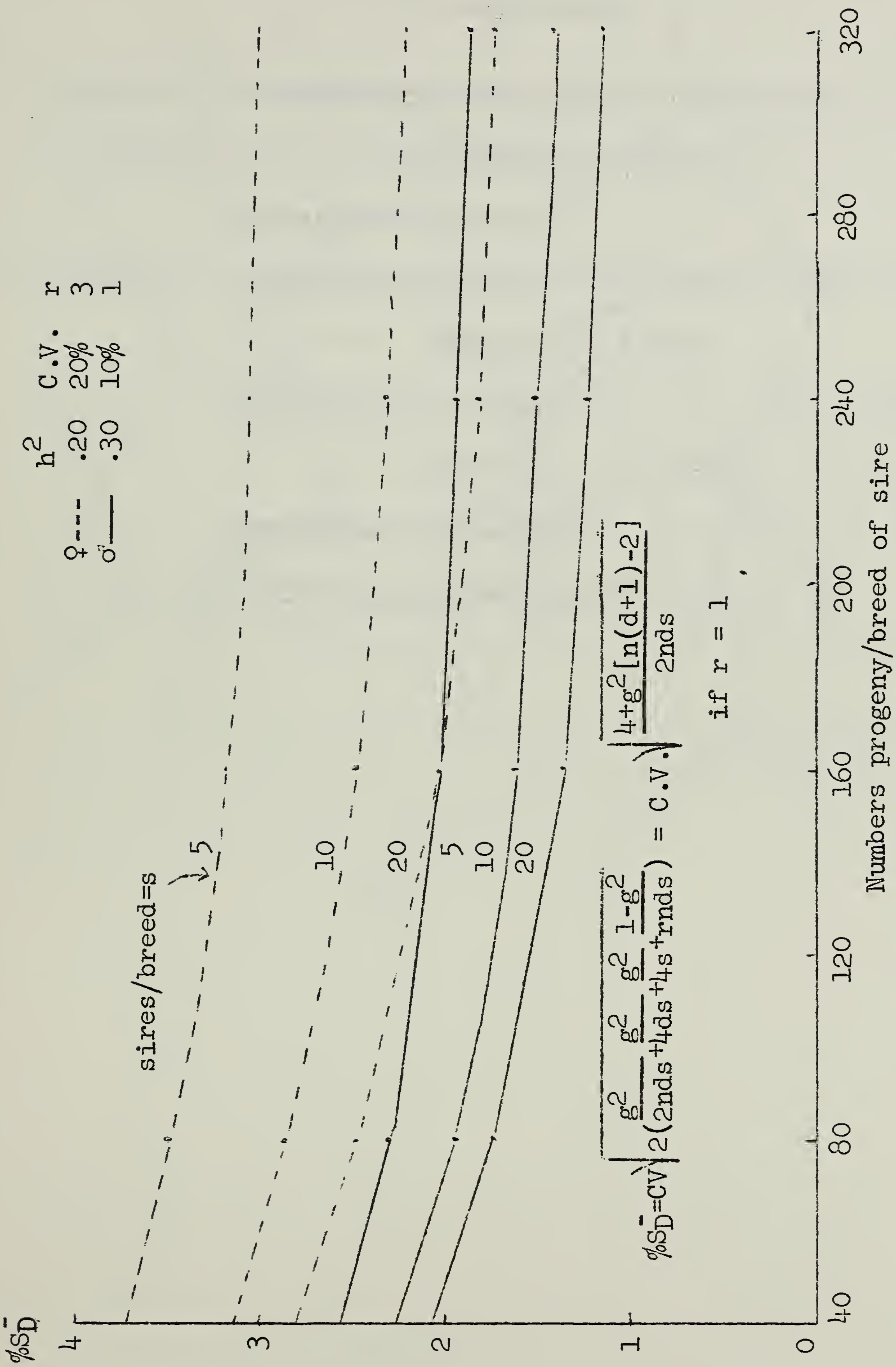
   a. F_3 for best 2 sire breeds, 2 dam breeds

   b. F_3 for best 4 breeds (ABxCD)

Reference

Dickerson, G. E. 1969. Experimental approaches in utilizing breed resources. Anim. Br. Abstr. 37:191.

Figure 5



%$S_{\bar{D}}$
4
3
2
1
0
40
80
120
160
200
240
280
320
Numbers progeny/breed of sire
sires/breed=s
5
10
20
5
10
20
h^2 C.V. r
♀---- .20 20% 3
♂—— .30 10% 1
$\%S_{\bar{D}}=CV\sqrt{2\left(\frac{g^2}{2nds}+\frac{g^2}{4ds}+\frac{g^2}{4s}+\frac{1-g^2}{rnds}\right)} = C.V.\sqrt{\frac{4+g^2[n(d+1)-2]}{2nds}}$
if r = 1

Figure 6

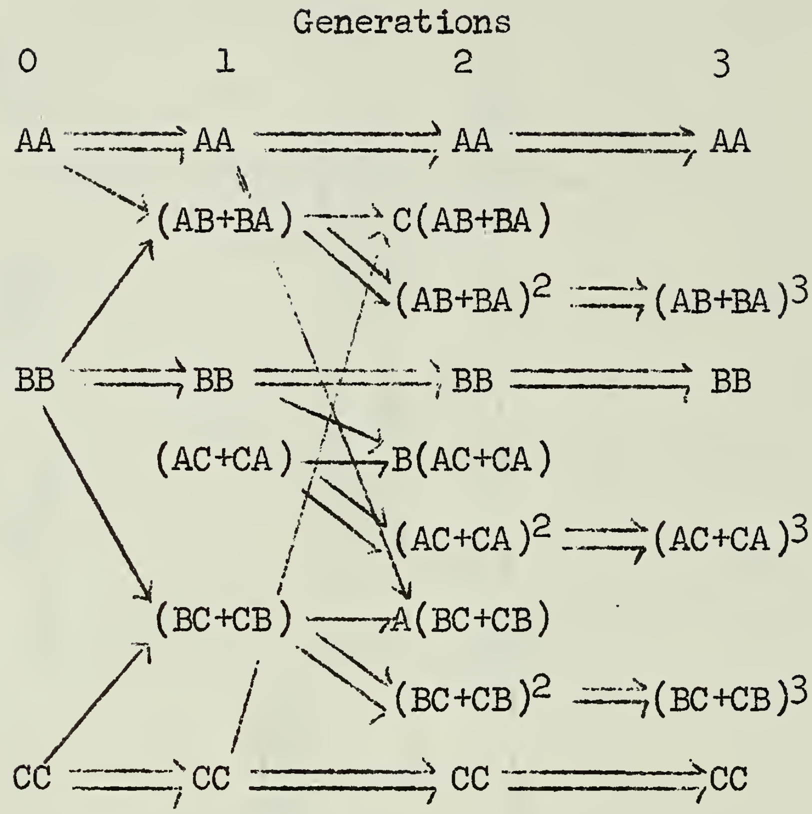
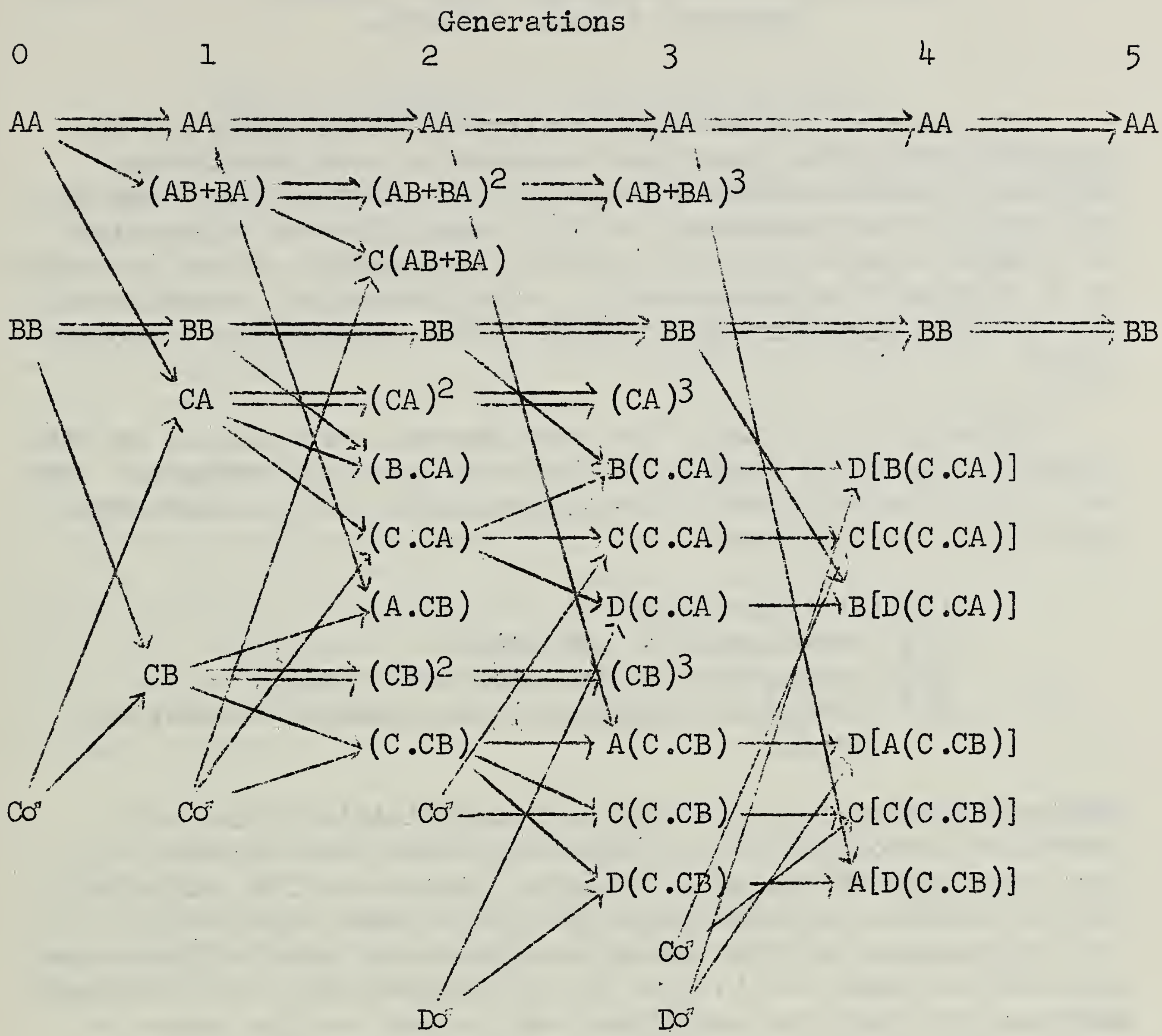

Generations
0
1
2
3
AA
AA
AA
AA
(AB+BA)
C(AB+BA)
(AB+BA)^2
(AB+BA)^3
BB
BB
BB
BB
(AC+CA)
B(AC+CA)
(AC+CA)^2
(AC+CA)^3
(BC+CB)
A(BC+CB)
(BC+CB)^2
(BC+CB)^3
CC
CC
CC
CC

Figure 7



Generations
0
1
2
3
4
5
AA
AA
AA
AA
AA
AA
(AB+BA)
$(AB+BA)^2$
$(AB+BA)^3$
C(AB+BA)
BB
BB
BB
BB
BB
BB
CA
$(CA)^2$
$(CA)^3$
(B.CA)
B(C.CA)
D[B(C.CA)]
(C.CA)
C(C.CA)
C[C(C.CA)]
(A.CB)
D(C.CA)
B[D(C.CA)]
CB
$(CB)^2$
$(CB)^3$
(C.CB)
A(C.CB)
D[A(C.CB)]
C♂
C♂
C♂
C(C.CB)
C[C(C.CB)]
D(C.CB)
A[D(C.CB)]
C♂
D♂
D♂

PROGRAMS TO UTILIZE BREED DIFFERENCES

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The role of beef breeding research, its adequacy and its potential direction, have been examined in some detail by previous speakers and more is yet to be said regarding some of the programs now underway. At this point it seems appropriate to consider some aspects of industry application of the knowledge to be derived from this research, with particular reference to the industry structure which might evolve over the next twenty years.

Interest in the topic has been focused rather sharply by the change in the breed importation policies of this continent. The new genetic material now becoming available will see industry application in four ways

(1) crossbreeding
(2) development of new breeds
(3) propagation of the imported breeds
(4) promoting competitive improvement of existing breeds

Advice of research people will be sought initially in the matter of breed choices for importation but hand in hand will come questions on the most effective procedures for utilizing the new breeds. At this point in time we have relatively little guidance to offer on either question. Breed differences are hard to gauge due in part to the extreme difference between European and American conditions and in part to the nature of the records available in Europe. Advice regarding potential application is equally hazardous. It is clear, however, that semen from all imported bulls will be preserved and widely disseminated for A.I. use. For the next decade at least, producers will be less concerned about following research projections than with exploiting the new and unproven. (It has been suggested that there is never an appropriate time to confuse the real issues with facts). For this reason the paucity of current knowledge is not a serious liability provided we move with reasonable speed and sureness to secure the information that will be required by the industry in the 1980's.

This, of course, is a large order. Before we can effectively discuss the utilization of breed differences we must attempt to define the performance traits of importance and rank them in terms of relative economic importance. From this foundation it might be possible to extrapolate to procedures for industry application. The first part of this presentation will consider

some components of net productivity. The second part will attempt to integrate this material in terms of industry application.

Part I. Components of Net Productivity

One measure of net performance is the lifetime production (pounds of calf weaned) of a brood cow. This will be a function of age at first calving, duration and regularity of reproductive life, and preweaning growth of her progeny. The latter will reflect both milk production of the dam and genetic growth potential of the calf. To rank these components in terms of relative importance it is useful to examine the influence of each on production costs. These include feed, labor, veterinary supplies and services, management skills, and the capital overhead of facilities, land and equipment. Each of these costs is highly influenced by environmental conditions, geographic location and management decisions. And to a certain extent each is conditioned by the environmental requirements of the chosen genotype or, conversely, by the economic consequences when such requirements are ignored. However, apart from tailoring genotypes to fit specific environmental niches, the primary production cost to be considered in genetic improvement is that of feed.

Critical research data bearing on the variables influencing feed requirements are limited but the topic can be explored by utilizing the N.R.C. standards for recommended nutrient requirements (3). One limitation to this approach is the feasibility of restricting feed intake to requirements. This point will be reconsidered later.

D.E. requirements for calf production

Total feed inputs required for a 1000-pound range cow, calving initially at 3 years of age, producing 11 lb. of milk daily during nursing, and weaning her fifth calf at 8 1/2 years of age for a life time production of 2000 lb. of calf (5 x 400 lb.) may be considered as a base (100%) with which alternatives are compared. This production pattern requires a life time feed input of 44,053 M cal or, in terms of calf production, the equivalent of 14.2 lb. of barley for every pound of calf weaned. Note that 19.5% of this feed charge would be required to carry the breeding female to her first calving and 9.9% would be an input to sustain lactation.

Net efficiency can be improved by decreasing the feed inputs prior to breeding and/or by increasing pre-weaning growth rate of the calves. Some examples of relative efficiency with

costs expressed as a percentage of the basis charge defined in the preceding paragraph are as follows (all examples derived from table 1).

1. More milk producing a 500# calf at weaning
   5 x 500 = 2500# of calf — 90.8%

2. Breeding to calve at 2 years
   6 x 400 = 2400# of calf — 89.7%

3. Calving at 2 years, more milk
   6 x 500 = 3000# of calf — 82.7%

4. Calving at 2 years, more milk, extra growth rate
   6 x 600 = 3600# of calf (not shown in table) — 68.8%

Assumptions made in respect of the relationship between milk production of the dam and weaning weight of the calf are derived from research reported by Berg et al. (1967, 1970), and feed requirements for milk production are calculated according to N.R.C. recommendations for dairy cattle.

Providing winter shelter for the brood cow reduces the maintenance inputs by about 17% (Webster, 1970) but this represents only about a 2.5% reduction of the life time feed budget.

Large cows--1300 lb. at maturity--have increased maintenance requirements and may be competitive with example 4 above only if they regularly wean calves substantially heavier than 600 pounds (e.g. a 1300 lb. cow weaning 6 calves at 600 lb. each is estimated to have a relatively efficiency of 80.9%).

Substantial savings in maintenance requirements might be effected by dry lot management of the brood cow. Webster (1970) has postulated savings approaching 50% although this may require downward revision.[1] The economics of such savings would have to be appraised in relation to changes in the costs of facilities and labor.

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[1] Webster (1970) estimates the daily energy expenditure of an 1100-lb. cow as 10,900 K cal if housed and 16,190 if on free range (i.e. an increase of 48.5% for walking and grazing). These figures, considered in relation to the NRC estimates of 15,200 and 17,640 K cal daily for maintenance of the dairy and beef cow respectively, indicate an energetic efficiency of 73% under housing and 92% under range conditions. Both figures are exceptionally high suggesting either that the NRC standards are too low or Webster's estimation too high.

The association between longevity--specifically number of uninterrupted calvings--and D.E. inputs per unit weight of calf weaned is illustrated by the 4 upper curves of Figure 1. A sharp decline occurs to about the third gestation but little further improvement occurs after the fifth gestation. Reproductive failure or preweaning loss of a calf would markedly increase the net requirements.

Also shown are curves (numbers 5 and 6) depicting the D.E. inputs required per pound of live animal produced (calf weaned and cow sold to slaughter) at the termination of the first, second or later gestation. Note that for these curves as for the other curves of Figure 1, the calculation of cow feed costs commences with the female selected at weaning. Restricting production to a single gestation with the dam fattened immediately for slaughter (at an assumed D.E. input of 2000 M cal) at 1000 lb. weight results in the lowest D.E. costs. These costs rise slowly with each additional gestation prior to slaughter of the dam. It should be noted that the upper (4) curves in the figure relate only to pounds of calf weaned whereas the two lower curves incorporate the postweaning gain of the dam. Including salvage value of the dam in the upper curves would shift them down and curves 3 and 4 would merge with curves 5 and 6 respectively at the extreme right of the figure.

The two lower curves of Figure 1 indicate that feeding the cow for slaughter immediately following production of her first calf (i.e. rearing the calf artificially or on other cows) would give a further slight improvement in net D.E. efficiency. Rearing the calf from birth to 400 lb. would require D.E. inputs of approximately 1380 M cal (dairy cattle standards). Feeding the dam to gain approximately 150 lb. over two months would require 2000 M cal. These inputs added to the 10,000 M cal required to rear the dam from weaning to the end of her first gestation (2 years of age) sum to 13,380 M cal to produce 1000 lb. of market product (1 calf at 400 pounds and 600-lb. gain for the dam).

Placed in a monetary context, barley at 2¢ per pound would equate to 1.3¢ per M cal. For gestation 1 of the curves in Figure 1 this means a feed cost per pound of weaned calf as 17.9, 18.2 and 23.6 cents for curves 6, 5 and 4, respectively.

For evaluating the relative economic merits of these alternate forms of the cow-calf operation, comparative D.E. inputs and relative costs of alternate D.E. sources do not provide a complete picture. Of rather crucial importance is the question of whether appetite at each production stage can be (or should be) tailored to match actual requirements. If such control proves impossible or economically unfeasible, projections based on energy requirements represent an exercise

in futility. But granting that such control is possible, there are other economic factors to be considered.

1. Relative economic value of a young vs. an aged cow.

2. Relative cost of facilities (important in the case of artificial rearing of the calf and also important if special feeding practices are required to ensure feed intake in accordance with requirements rather than appetite).

3. Availability and dollar cost of replacement heifers. Slaughter of all females following birth (or weaning) of their first calf would mean annual replacement of all cows in the herd. The implication of this requirement (e.g. with a 50-50 sex ratio this would mean the marketing of two females, one cow and one heifer calf, for every male produced) suggests that the practice would be totally impractical unless multiple births and/or sex control become practical realities.

4. The logistics of annual replacement of all proven reproductive units with heifers of unknown and untried potential. Conception rate might be of minor importance since pregnancy testing would permit early marketing of non-pregnant females. However, the economic implication of such culling is obviously dependent on the relative values of replacement heifers and slaughter cattle.

5. The greater incidence of calving difficulties among heifers, and the lower lactation and hence lighter weaned calf weights characteristic of first lactations. The latter point would not apply if calves were reared artificially.

Most of these factors tend to weaken the economic argument for termination of reproduction after a single lactation. Thus the cow-calf operation is likely to continue in the present production pattern for some time to come. For this reason the industry will be interested in small brood cows, maturing at 1000 lb. or less, capable of producing abundant milk and weaning large calves annually from the age of two years. Such cows would require extra management during lactation; under range conditions they would be unlikely to have the opportunity or capacity to consume D.E. sufficient to lactate and simultaneously maintain a condition adequate for reproduction and/or winter survival. Failure to wean a calf in any year would markedly increase the production costs.

Among the implications in this definition of the "ideal" brood female is the fact that any breeding program designed to produce her will inevitably produce cull females and males with a comparable growth rate and mature size.[2] To appraise the

economic consequences of this fact requires an examination of the energy inputs required for rearing cattle to market weight.

D. E. requirements for feed lot gains

Three variables influencing the total D.E. requirements for feed lot gains are

1. Weight of calf at start of feeding; light calves will be longer in the feed lot and thus will incur higher maintenance charges.

2. Rate of growth permitted during the initial part of the feeding period; the more rapid the growth the lower the maintenance charges.

3. Final market weight; light terminal weights will result in lower feed requirements for both maintenance and gain.

It is obvious that maximum efficiency in D.E. utilization is not necessarily equivalent to maximum profitability. The latter will depend on the relative costs of different D.E. sources (e.g. energy derived from barley grain would cost approximately 25% more than energy derived from brome hay) and the relationship between market value and terminal weight and/or degree of fat cover on the carcass. But considering only the question of D.E. inputs, the most efficient conversion is achieved by minimizing maintenance charges--a combination of light initial weight, maximum growth rate and a relatively light terminal weight. Thus a steer placed on feed at 400 lb. and marketed at 1000 lb. by 13 months could produce each unit of live weight gain at a cost of 5.8 units of barley. Alternatively, a 600 pound steer fed to the same terminal weight at 11 months would require approximately 5% more feed (6.4 units of barley) per unit of live gain. At a terminal weight of 1200 lb. the difference in feed requirements increases to approximately 6%.

The 200 lb. difference in 180 day weaning weight represents a difference of 33% in preweaning growth. If this difference carries forward, the figures for a 400 lb. calf gaining 3 lb. per day should be compared with a 600 lb. calf gaining 4.5 lb. per day. The latter would then require 5.5 lb. per pound of gain to 1000 lb., or an improvement of approximately 5% over the lower gaining calf. Further, if feed requirements are a

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2 Successful techniques for sex control, or incorporation of genes which produce sex dimorphism in respect of growth rate would permit modification of this statement.

function of age rather than weight for these youthful cattle, the advantage of the rapid gainer would increase to 18% (4.8 units of barley per unit of gain).

Two points of importance to the beef industry are illustrated by comparison of tables 1 and 2. First is the fact that the feed inputs involved in producing a weaned calf are substantially larger than those required to carry the calf from weaning to slaughter weight (barley equivalents of 9.8 vs. 4.8 for the two most efficient examples of pre- and post-weaning growth from the two tables). This reinforces the early conclusion regarding the importance of minimizing D.E. inputs for weaned calf production. Second, heavy calves at weaning, a requisite to minimizing preweaning D.E. charges, will be most profitable in the feed lot provided that their superiority in preweaning daily gain carries forward into the feed lot. This advantage will be particularly marked if their younger age at the terminal market weight means a leaner carcass.

The estimates of table 2 indicate the need for considering the total economic implications associated with production of the "ideal" small brood. However inferior growth rate is not a prerequisite to light mature weight (i.e. 1000 lb.). Specific breed crosses may offer a useful method for combining rapid growth with minimum mature weight.

D.E. requirements in relation to lean content of the carcass

Marketing decisions are based on many factors but of paramount importance is the desire to achieve the market weight and grade commanding above average prices. Insofar as North American markets are concerned these criteria generally specify market steers or heifers (not bulls) in the live weight range 950 to 1150 lb. and carrying above average fat cover. Implications of these criteria in respect of D.E. utilization are indicated by the data of table 3 (adapted from Fredeen, 1970).

Lean content of the carcass (expressed as a % of live weight at slaughter to accommodate the direct relationship between dressing percentage and carcass fat) decreases with increasing fat cover. Bulls yield more lean and heifers less than steers of the same average rib fat (e.g. at 0.7" average fat averages for % yield of lean were 31.1, 28.2 and 29.8 for bulls, heifers and steers). Feed figures were not available for heifers but the D.E. required per unit of live gain would undoubtedly follow the same trend as for bulls and steers, increasing with increasing fat cover. With sexes compared on an equal rib fat basis bulls were approximately 25% more efficient than steers in D.E. conversion to lean. (Barley equivalent per unit live gain with the comparison made for

average rib fat of 0.5" was 7.46 for steers and 5.18 for bulls). This reflects the combination of more rapid gains and higher lean content.

The data of table 3 clearly demonstrate the potential economic advantages to be derived by minimizing fat production and by feeding entire males rather than steers for slaughter. The fact that these specifications are contrary to the "best beef" image currently promoted by the retail trade should be a matter of grave concern to the beef industry.

Part II. Industry Application

The upward trend in consumer preference for beef has created great optimism in the beef industry. Beef prices have not declined in spite of increasing prices--it is estimated that 75% of the consumer meat dollar is spent on beef--and increasing per capita demand coupled with increasing population size has encouraged some amazing projections for the beef production required in the relatively near future.

Perhaps the projections are correct, but we must not ignore the fact that they are based on the exceedingly fragile foundation of consumer demand. People have no unalterable convictions and the present infatuation with beef probably should be viewed as a testimonial to the consistency and persistency of retail promotion over the past several decades rather than growing allegiance to the product. Unless the beef industry moves soon to establish a strong competitive position producers may be reminded forcibly that there are alternate meat products including the so-called protein extenders.

This statement applies to the entire industry, not to producers alone. Indeed some major contributions to inefficiency occur in the merchandizing procedure. Further, traditional product specifications, entrenched in carcass grading procedures and vigorously protected by vested interests of the retail trade, have discouraged the development of tangible economic incentives for lean meat production. But these aspects of the industry are changing and the onus is on the producer to evolve production techniques that will improve the competitive position of beef relative to other meats.

The material of Part I provides some guidance on specifications for the productive unit--brood cow and weaned calf--that will maximize production per unit of feed input. These specifications are:

1. Brood cows - producing their first calf at 2 years of age.
   - capable of uninterrupted reproduction and calf production to weaning as long as they remain in the herd. Longevity (beyond 6 1/2 years) is of secondary importance.
   - capable of producing abundant milk.
   - producing calves with rapid growth and high weaning weights.
   - maturing at a weight of approximately 1000 pounds.

2. Weaned calves - that reach the desired market weight at a minimum age.
   - that are physiologically young at the chosen market weight to minimize fat content.
   - that possess abundant muscling.

None of our existing breeds meet all of these specifications. Further, the reproductive advantages of hybrid heifers (earlier puberty and higher conception at first service) coupled with the opportunity afforded by crossbreeding for combining in one animal the desired traits of two or more breeds support the view that hybrids, not straightbreds, will be the brood cows of the future. The calves they produce will in turn represent another cross with the top cross bull breed chosen in accordance with the characteristics required for specific markets. Growth rate, carcass muscling and physiologic age at a designated market weight (as a control on the degree of fatness) will be primary considerations.

Development of demand for hybrid breeding stock would support the following industry structure:

1. Selective propagation of foundation (straightbred) lines designed for producing F_1 hybrid females and top cross sires. (The lines may be breeds or synthetic lines).

2. Large scale production of hybrid females for breeding use (may be combined with foundation herd operations).

3. Commercial production based on hybrid females.

This projection of industry structure is not new and logistics concerning its application may be deduced from experiences with poultry and pigs. From these experiences we can also conclude that the successful seed stock enterprises will involve large herds of breeding females which, if not singly owned, are under single direction in respect of selection and breeding decisions. (This, of course, is the direction indicated by population genetics theory and proven by practical experience). Similarly, enterprises geared to the production

of hybrid females must be of sufficient size to guarantee continuous supplies of quality stock in such quantities (and at prices) that can support effective sales promotion. It is almost certain that those who merchandize hybrid females will seek to establish complete control of the foundation lines involved.

The basic breeding research required for effective advancement of this industry structure has already been done. What remains is research documentation of the specific role which may be played by established and, as they become available, the foreign breeds. Public (i.e. tax supported) research may make a relatively small contribution to this documentation; limited research resources will hamper investigations of the potential multitude of breed crosses and/or environmental circumstances. Further, the industry will not be content to wait for the outputs from planned research. Instead producers will make commitments to breed combinations well in advance of--and often in spite of-- research evidence. Having made their moves the time and cost involved in switching from a known quantity for which markets have been developed to possibly superior but unknown products will serve as a strong deterrent.

However, industry will assume a commanding position in new breed and breed cross evaluation (as an example consider the Conception to Consumer progeny testing program of the Canadian Charolais Association which has now been broadened to include the Simmental) and trained animal breeders will be challenged to provide guidance on the design of effective testing programs and the interpretation of results. It is in the training of these technical advisors that beef cattle research will play its most vital role. Research with laboratory species or with poultry or pigs will be a useful supplement but nothing can replace a thorough exposure to the problems of beef cattle husbandry.

Does the future for beef breeding research hold nothing more demanding than the training of industry advisors? Are there no major scientific contributions to be made? Before considering this second question the record of research in animal breeding should be examined. Over the past 40 years such research has had a profound impact on poultry breeding and contributed substantially to pig breeding practices. A large body of evidence directly applicable to the beef industry has also been developed. But the beef industry, hampered by the slow reproductive rate of their species and inhibited by tradition, has been exceedingly reluctant to support genetic research or to accept the new breeding and selection technology.

The situation has changed dramatically in the past five years. Beef breeding research is now front center of the stage

with other species occupying the wings. This shift in fortunes should serve to remind us that beef breeding research is also expendible. Today's society is preoccupied with finding solutions to crises. Once a crisis has passed those who found and applied the solution are forgotten in the rush to deal with another crisis. In short, the reward for success is obscurity. Relative obscurity has been the reward granted poultry and pig research programs; in time it will be the reward granted beef cattle research. The current fever of interest in beef cattle breeding is a transient phenomenon. While it lasts, research agencies will be exhorted to open doors to importation of all possible genetic material, to produce quantities of technical information regarding optimum breed combinations and to update the research evidence on crossbreeding systems. And when it subsides, beef cattle research will be shuffled into the wings while another performance--perhaps the development of meat substitutes--moves forward to dominate the scene.

Now, while interest runs high, is the opportunity to develop strong research facilities and programs for beef cattle research. The new breeds being imported bring with them new dimensions of performance in growth rate, mature size, lactation potential and muscling. To document even a modest amount of information on effective ways for incorporating these features in our beef industry will occupy much of our research resources during the decade ahead. We cannot side step this obligation. The questions being raised by beef producers are entirely pertinent and until industry is in a position to secure this information by other means research institutions must fill the void. But in this process, the overall research plan must be aimed beyond the immediate horizon of crossbreeding. We do not as yet have solid answers on many of the basic issues in beef cattle production. A few examples with implications to the animal breeder are:

> Energetic efficiency in the transformation of digestible energy and/or protein to edible product, a process that must start with the rearing of the replacement female and ends with the retail product. Perhaps it is well to re-emphasize here the fact that feed requirements and feed consumed are not synonymous. The unknown is appetite which generally will exceed functional requirements. Research has yet to secure an answer to the question of optimum procedures for measuring feed "efficiency," or to untangle the genetic implications of adopting results obtained from one vs. another of the several feed efficiency criteria now available.

> Effective, reliable and practical performance evaluation techniques and procedures. This embraces the securing of methodology for live animal evaluation, defining and

quantifying environmental inputs to observed differences, and development of appropriate selection procedures.

The possibilities for improved reproductive performance and the genetic aspects of response to estrus control, superovulation and other techniques for manipulating reproductive potential.

Procedures for exploiting special genetic situations such as muscular hypertrophy and the possibility of developing special purpose lines with a high response to physiological manipulation (e.g. exceptional muscular development following androgen therapy).

Relative response of different lines and/or crosses to intensive management (confinement).

Conversely, the relative response of different lines to low intensity management, specifically the question of converting coarse feeds (by products of cereal grain production) instead of the high energy grain itself.

A closer examination of the relative economic merits of specific 3-way crossing (as outlined here) and rotational crossbreeding. It is certain that the latter will be used extensively by the industry, in fact it along with straight breeding, single crossing and back crossing will probably continue to supply most of the commercial slaughter cattle for the next several decades.

These few examples have not been listed with any thought to relative importance. They are cited only to support the optimistic view that beef breeding research is still in its infancy with a long and productive life ahead. The present climate is favorable, and programs designed to focus on these kinds of issues will continue to bear fruit years after the current activity with new breeds and crosses has been woven into industry practice.

One other area may offer a special challenge to the animal breeder. Each of the new breed societies (Charolais, Simmental, Limousin) have provided for the recordation of first crosses. This is a logical decision in view of the scarcity of imported females and the relative abundance of new breed semen. Societies representing the long established breeds have not been oblivious to the challenges posed by the new breeds and several have reacted by opening their herd books to permit entry of the glamorous foreign blood. The consequences are reasonably predictable; the so-called pure breeds will become genetic mixtures and, depending on how rapidly the integration proceeds, the breeds for which we document breed and breed

cross data today will not be the same genetic entities in another 10 or 20 years.

It is clear that our breed societies are taking a realistic approach. The Hereford, if it is to compete with the Simmental, must try to borrow on a permanent basis some of the genes of the Simmental breed. Similarly the Shorthorn and Angus, without marked change in their color and type requirements, will inject Limousin into their breeds. By legalizing this procedure of gene migration the breed societies will combine advancement of their breed with maintenance of breeder integrity.

But this process raises the important question of whether unidirectional selection in all breeds is the most effective mode of beef cattle improvement. Further, we must ask whether this melding of breeds will enhance or detract from the potential for exploiting hybrid vigor. Who will maintain, and in what form, the strains for crossing programs? The last question may be irrelevant. Breed societies, the one force that attempts to define and maintain pedigree barriers, owe their existence to the multitude of small breeders. The latter will be a casualty of research technology; they lack the resources to apply the techniques and breeding programs required to remain a viable part of the seed stock industry. With their passing from the scene, breed societies shorn of their main source of revenue will also cease to exist or will become the refuge of fanciers who are removed from the mainstream of economic responsibility to beef cattle production. At that point in time each main breed, or a synthetic derived therefrom, will have been subdivided into lines maintained by individual large scale seed stock producers.

The development will tend to enhance opportunities for developing distinct lines, each selected toward a somewhat different goal. For this reason the first question--the desirability of unidirectional selection--may also be irrelevant. But the second question concerning future opportunities for exploiting hybrid vigor and the allied question of how best to evolve superior foundation lines for crossing purposes remain unanswered. Time is too short to permit appropriate research with cattle. Instead the answers must be sought from experiences with other livestock species augmented by detailed pilot studies with laboratory animals. To engage in or be associated with such investigations is as pertinent to beef breeding research as investigations with the species itself.

One final comment. The animal breeder cannot effectively discharge his responsibilities unless he takes a comprehensive view of the environmental framework--economic and biologic--within which beef production occurs. By the same token, economists, nutritionists and others cannot contribute

effectively unless they have some understanding of the biological and genetic constraints that exist with the species. The speed and effectiveness with which all disciplines combine their efforts will have a profound effect on the vigor of the beef industry two decades hence.

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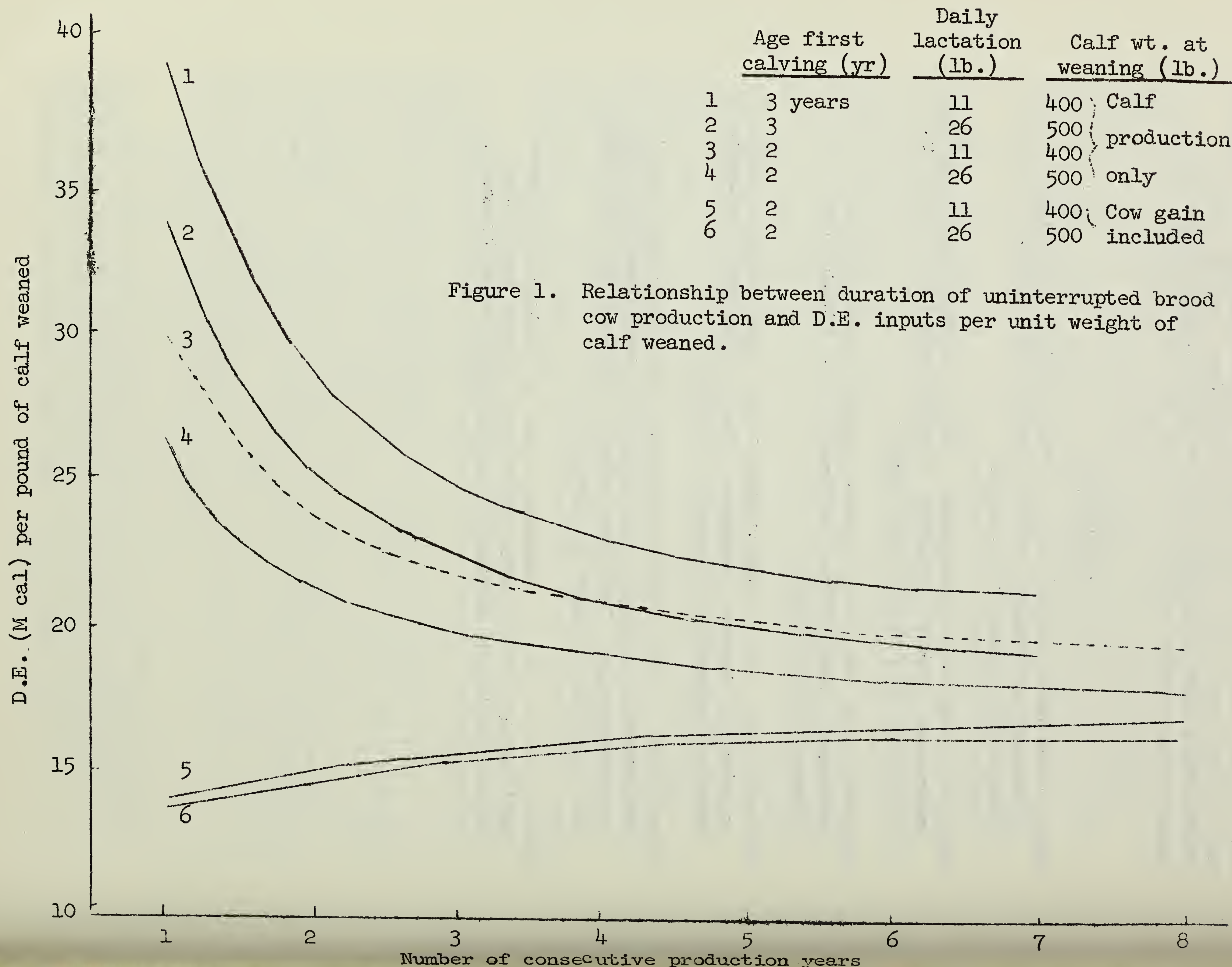

Figure 1. Relationship between duration of uninterrupted brood cow production and D.E. inputs per unit weight of calf weaned.

Table 1. Lifetime feed requirements (M cal) for brood cow maintenance and reproduction

Weaning weight (lbs.)	400		400					500	
Age at breeding (mos.)	27		15					15	
Weight at breeding (lb.)	900		900					900	
Weight at calving (lb.)	1000		1000					1000	
Mature weight	1000		1000			1000		1300	
Milk production (lb/day)	11	26	11	26	26 (Winter shelter)	11	26	11	26
D.E. to first breeding	8593		4880			5114		5114	
			5238 M cal to calving of first calf						
D.E. to first calf weaned	7092	8280	7092	8280	8084	7092	8280	8841	10060
D.E. to second calf weaned	7092	8280	7092	8280	8084	7092	8280	9071	10290
D.E. to third calf weaned	7092	8280	7092	8280	8084	7092	8280	8571	9790
D.E. to fourth calf weaned	7092	8280	7092	8280	8084	7092	8280	8280	9500
D.E. to fifth calf weaned	7092	8280	7092	8280	8084	7092	8280	8280	9500
D. E. to sixth calf weaned	7092	8280	7092	8280	8084	7092	8280	8280	9500
Total D. E. to 8 1/2 years	44,053	49,993	47,432	54,560	53,384	47,666	54,794	56,437	63,754
Calf size at weaning (lb.)	400	500	400	500	500	400	500	400	500
M cal/lb calf weaned	22.03	20.00	19.76	18.19	17.80	19.86	18.26	23.52	21.25
Barley equivalent (lb.)	14.21	12.90	12.75	11.73	11.48	12.81	11.78	15.17	13.69
% D.E. for milk	9.9	20.9	11.1	19.2	19.6	11.0	22.9	9.2	19.7
% D.E. for rearing cow	19.5	17.2	10.3	8.9	9.1	10.7	9.3	9.1	8.0

1 g TDN=4.4 K cal; 1 lb barley=1550 K cal; 1 lb brome hay=1000 K cal; Milk production at 11 lb daily is considered about average for beef cows (Berg and Peschiera, 1967) during the first 120 days of lactation.

Note that annual requirements of 7090 M cal are roughly equivalent to the D.E. production from 2 1/2 acres of barley (30 bush/acre), 2 to 7 acres of brome hay (3000 to 1000 lb/acre) or 12 to 30 acres of short grass pasture (1000-30 lb/acre).

Table 2. Energy requirements (M cal) for feed lot finishing of beef cattle weaned at 180 days

Average daily gain (lb.)			1		1.5		2.0		3.0		4.5	
Weight (lb) Start	Finish		Maint-enance	Total	Maint-enance	Total	Maint-enance	Total	Maint-enance	Total	Maint-enance	Total
400	1000		5980	9340	3988	7348	2989	6349	1993	5353	1315	4675
		Age (mo)	26		19		16		13		10	
	1200		8825	13805	5884	10864	4412	9392	2941	7921	1940	6920
		Age (mo)	33		24		19		15		12	
600	1000		4409	6919	2940	5450	2204	4714	1469	3979	969	3479
		Age (mo)	19		15		13		11		9	
	1200		7254	11384	4836	8966	3627	7757	2417	6547	1594	5724
		Age (mo)	25		20		16		13		11	
600*	1000		4409	6389	2940	4920	2204	4184	1469	3449	969	2949
	1200		7254	10614	4836	8196	3627	6987	2417	5777	1594	4954
		Total feed inputs (M cal) per pound of gain (barley equivalent in brackets)										
400	1000		15.6 (10.0)		12.2 (8.0)		10.6 (6.9)		9.0 (5.8)		7.8 (5.0)	
	1200		17.3 (11.2)		13.6 (8.8)		11.7 (7.5)		9.9 (6.4)		8.6 (5.5)	
600	1000		17.3 (11.2)		13.6 (8.8)		11.8 (7.5)		9.9 (6.4)		8.7 (5.5)	
	1200		19.0 (12.3)		14.7 (9.5)		13.0 (8.4)		10.9 (7.0)		9.5 (6.2)	
600*	1000		16.0 (10.3)		12.3 (8.0)		10.5 (6.8)		8.6 (5.5)		7.4 (4.8)	
	1200		17.4 (11.2)		13.7 (8.8)		11.6 (7.5)		9.6 (6.2)		8.2 (5.3)	

* These calculations assume that feed requirements for growth only are a function of age not weight.

Table 3. D.E. requirements in relation to composition of body weight gains

Sex	Av. rib Fat	Number of animals	Yield of lean (%)[a]		Days on test		Live wt at slaughter (lb)		D.E. consumed K cal/day		Number[b] of animals	D.E. per unit lean gained[c] K cal/day	
			Av	SE	Av	SE	Av	SE	Av	SE		Av	SE
Steers	0.3	4	30.9	.7	107	19	865	12	21.3	2.8	3	26.7	1.2
	0.5	29	30.6	.2	135	4	920	20	21.9	0.6	15	35.4	3.2
	0.7	63	29.8	.2	145	3	966	15	22.7	0.6	21	36.1	1.2
	0.9	47	29.1	.2	156	7	992	14	22.7	0.8	12	36.6	1.5
	1.1	16	28.8	.3	158	5	983	18	23.8	0.6	9	38.8	0.6
	1.3	9	28.2	.4	185	-	1123	18	25.7	0.3	6	40.2	1.5
	1.5	-											
Heifers	0.1	-											
	0.3	1	27.2	-			655	-					
	0.5	9	29.0	.7			820	23					
	0.7	57	28.2	.2			835	11					
	0.9	60	28.1	.2			880	10					
	1.1	18	27.9	.4			885	20					
	1.3	2	26.9	.3			970	85					
	1.5	-											
Bulls	0.1	4	35.2	.9	262	22	964	105	18.1	2.0	4	26.6	2.1
	0.3	27	33.6	.5	252	8	1027	33	20.7	.9	19	25.7	1.0
	0.5	103	31.6	.2	242	4	994	15	20.8	.5	47	25.4	0.5
	0.7	65	31.1	.2	256	6	1015	15	20.7	.3	46	27.0	0.4
	0.9	38	30.7	.3	271	6	1095	22	21.5	.4	36	27.8	0.5
	1.1	14	30.8	.4	282	7	1120	34	21.9	.5	14	29.4	0.8
	1.3	6	30.2	.5	395	10	1209	47	24.5	.6	6	30.5	0.6
	1.5	2	28.5	1.0	315	-	1315	5	24.5	.7	2	30.6	2.3

[a] Deboned-defatted lean (muscle) tissue of the primal cuts expressed as a percent of live slaughter weight.

[b] These numbers apply to the 66 steers and 174 bulls for which feed consumption and days on test were recorded.

[c] This assumes that composition of the gain on test (i.e. post weaning) was in the ratio observed on the carcass.

S-10 REGIONAL GOALS FOR COOPERATION WITH THE U.S. MEAT ANIMAL RESEARCH CENTER

J. W. Turner

Defining regional goals for cooperative research with the U.S. Meat Animal Research Center (MARC) would, at first, appear to be a simple task. All research efforts are aimed at common goals of increased production at reduced costs by accumulating knowledge. Cooperative effort implies effective communication and organization of complementary projects to insure an organized, integrated research effort of mutual benefit. However, regional goals must necessarily be identified with individual station projects since the regional effort is cooperative.

Cooperative efforts of S-10 contributing stations with the MARC might best be characterized by defining mutual benefit. The MARC possesses facilities and supporting personnel that cannot be duplicated at any individual station. As a research facility, undivided attention to research planning, execution and analysis is assured. However, there are lingering questions relative to genotype x environment interactions and specific management techniques dictated by environmental conditions that detract from a strong, centralized facility effectively contributing material benefit on an applied basis. Therefore, it would appear that particular cooperation should be developed in the choice of research problems conducted by the various stations. Certainly major attention at the MARC should be directed to basic work and each localized station should consider more applied problems.

With reference to existing projects, the MARC can possibly supply valuable assistance. Specifically, the MARC might ably assist in feedlot and carcass evaluation of progeny from cooperative projects. The South is not noted for its feedlot industry and most individual stations do not possess facilities to feed and evaluate any sizeable number of progeny. Realizing that the beef industry is segmented, the MARC might benefit by accumulating large samples of cattle for feeding studies that would parallel feedlot industry situations.

Opportunities certainly exist for exchange of experimental animals to evaluate genotype x environment interactions. It is most important that such interactions be investigated for selection decisions. Such exchange will allow the MARC to accumulate samples from many herds for determining herd differences.

Paramount to the establishment or execution of cooperative efforts, close personal communication of principles must be insured. Cooperative agreements often yield no results due to

the lack of communication. Therefore, individual project leaders stationed at the MARC and with each cooperative station will supply the impetus for a true cooperative effort. Administrative assignment alone will not suffice to direct cooperative research.

It would appear that a precise definition of cooperation is required to relate to needed goals. Webster's Seventh New Collegiate Dictionary presented three definitions. The first, reads "the act or process of cooperating." This is of no value since cooperation is defined with itself. The second definition reads, "association of persons for common benefit." While this has merit for this group it does not directly relate. Therefore, the third definition must surely relate. It reads, "a dynamic ecolcgical state of organisms living in aggregation characterized by sufficient mutual benefit to outweigh disadvantages associated with crowding"! Paraphrasing this definition does define our goals. Animal agriculture research is dynamic and the individual research station must identify itself with the research community. State stations and the MARC need open avenues of communication and vital personnel interested in a stronger beef industry.

COOPERATION BETWEEN THE WESTERN REGION AND THE U.S. MEAT ANIMAL RESEARCH CENTER

C. M. Bailey

There has been considerable discussion among animal scientists in the western states concerning the relation of research activities at State Experiment Stations with programs that are under development at the national research facility at Clay Center. Numerous recommendations have been made for cooperative work programs involving state institutions and the U.S. Meat Animal Research Center. Those that I will refer to here today have been proposed by the members of the W-1 Technical Committee. Each recommendation should be considered within the framework of a total, integrated program contributing to a regional or national goal rather than as a separate entity.

1. First, it is apparent that the U.S. Meat Animal Research Center can have a key role in the training and professional development of animal scientists. As laboratory facilities are completed and as staff positions are filled, graduate students and scientists from other institutions can receive specialized and advanced training at the Center and, under certain circumstances, participate in on-going research projects. Perhaps in the future it will be possible to establish U.S. MARC fellowships for pre-doctoral and post-doctoral programs. Provision should also be made for U.S. MARC staff members who wish to study with other research groups.

2. In many instances the interpretation of results from beef cattle breeding studies would be enhanced by the inclusion of control groups to evaluate genetic changes. Consideration should be given to the possibility of establishing a regional control program, utilizing control herds at Clay Center as a standard. Such a program would necessitate the use of artificial insemination and, conceivably, ova transplants could be employed in the future to reconstitute control stocks at different locations as needed.

3. Many outstanding herds of the established breeds have been developed in conjunction with teaching and research programs at state universities. These cattle represent a wide variety of types and bloodlines and could be used efficaciously as source stocks for projects at Clay Center including the germ plasm evaluation study. Benefits to cooperating stations would include an opportunity to obtain useful progeny data and at least in a limited way to compare sires from different breeding groups. A regional or inter-regional genotype x environment interaction study could be incorporated into the overall project.

4. A wide diversity exists in forage resources, disease and climatic conditions, and in economic factors in different parts of the United States. Specifications for breeding stocks and management concepts that are appropriate for one area may be entirely inadequate under other sets of conditions. Consequently, it will be necessary to determine the relative utility of the more promising breeds and breed combinations in different production areas throughout the country in order to provide recommendations for industry. This will be a task of major proportions that will require concerted action at the national level.

5. The creation of a germ plasm depository at Clay Center would facilitate projects such as those that I have just outlined, thus furnishing needed flexibility in the prosecution of long-term objectives at cooperating stations. Such an installation could also serve as a national reservoir for exotic and/or rare germ plasm.

6. Other areas of cooperation would include laboratory testing services, statistical services, and the exchange of tissues, samples and data.

Some of these suggestions could be implemented at little additional cost, while others would require selective increases in support funds or a shift in research emphasis at some stations. In any event, I think that we all agree that the programs at Clay Center and those conducted at other stations should be coordinated with planning at each stage based on mutual understanding and effective communication so that capabilities of all agencies can be fully utilized.

This year following the termination of the W-1 Project a new committee was established to coordinate beef cattle breeding studies in the Western region. Each of the State Experiment Stations was invited to participate. Federal participation includes representatives from the U.S. Range Livestock Experiment Station, Miles City, Montana; the Agricultural Research Service Beef Cattle Investigations Leader's Office, Fort Collins, Colorado and the U.S. Meat Animal Research Center at Clay Center. The Committee, which has been designated WRCC-1, will critically examine the functions of genetics and breeding along with other disciplines in the development of efficient, total production systems for the western cattle industry. The WRCC-1 Committee will also provide liaison at the active research level between Western State Experiment Stations and the U.S. Meat Animal Research Center.

PRACTICES AND PRINCIPLES OF BEEF CATTLE BREED IMPORTATION AND EVALUATION, WITH SPECIFIC REFERENCE TO CANADA'S PROGRAM

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Much has already been said at this meeting about the need to clarify objectives, to put things in perspective, and to get on with the job of breeding beef cattle so as to maximize efficiency of production of animal protein. Thus, systems which will apply known knowledge and quickly develop needed knowledge to accomplish this objective must have priority in our planning.

Numerous concepts in the past have reduced the rate of advancement of the beef cattle breeding industry to an even slower pace than that dictated by the long generation interval. Little is gained by enumerating these, other than to suggest that they have been reflected in a reluctance to interfere with the existing industry structure. It can also be stated that limited international movement of breeding stock in the past has significantly retarded acceptance of new approaches, inasmuch as it has tended to protect the established domestic breeds and, by so doing, permitted outmoded concepts to dominate in the industry beyond their period of usefulness. The opening up, in 1965, of quarantine facilities, to admit western European beef cattle breeds into Canada and into North America has been followed by an exciting surge of interest in new beef breeds and what they can contribute. To say that this development is entirely synonymous with greatly increased awareness of constructive breeding programs would be completely naive; the "fast buck" concept is what has generally prevailed. But it does seem evident that there is now a much more receptive audience to whom discussion and recommendations on long-term breeding plans can be addressed. Since breed utilization through the importation program has necessitated crossbreeding, and since the breeds and individuals selected have probably been in the upper range of performance merit, the result has helped to sell a concept, or at least establish good communication, more effectively and more quickly than ever before in beef cattle breeding. Thus, the potential of exploitation of available germ plasm resources through a livestock importation facility provides a new dimension to livestock breeding which is very much needed if beef production is to remain competitive.

The first isolation unit for importation of livestock from western Europe (primarily France and Switzerland) was established by the Canada Department of Agriculture at Grosse Ile in the St. Lawrence River in 1964. The capacity was initially for 110 head of cattle. The unit was doubled in capacity the next year. In 1969, the quarantine facilities were expanded by the opening

of another station, of equivalent size, on the island of St. Pierre off the coast of Newfoundland; this unit can be used twice per year. Thus, the total import capacity now is about 600 head per year. The stations provide for all possible precautions of disease control. Whereas the importation program was identified initially with the Charolais breed only, there has been increased importation of other breeds, the Simmental, Limousin, Maine Anjou and Brown Swiss being among them. The total number of animals imported, including those presently being purchased for entry, is over 2000.

While major attention of necessity has been given to ensure completely adequate disease control, this is only, in effect, the mechanics of providing access to new breeds, providing added genetic variability for breeding improvement. In recent years a technical advisory committee has reviewed breeding plans put forward by applicants requesting importation permits and has recommended priorities based on the proposals as presented. Emphasis has been given in the recommendations of the committee to establishing adequate numbers in breeds which seemed most clearly to provide a potential for improvement in the industry, and to encouraging buildup of limited numbers of herds to the point where they could begin to develop effective breeding programs. Accordingly, it has discouraged single animal importation as this does little for the concept of industry development on which the policy should be based.

If optimum use of an importation facility for the long-term benefit of the industry is accepted as being desirable it serves to underscore more than ever the need for effective planning and forward thinking in livestock improvement. Such planning should be based on careful evaluation of the biological potential of the species, as well as taking into account the nature and the structure of the industry involved. Accepting this as an objective, to gear this program to the needs of the 70's, some basic decisions have to be made, both of an administrative and technical nature. One of the most important decisions, and perhaps the most difficult, is essentially a political one. It is whether or not the government will assume the authority to decide how the facility should be used, having accepted that it was established for the purpose of livestock improvement and this is thus not different from other industry improvement programs. Since the facility is limited, two alternatives exist. One is to formulate a planned importation procedure, in the sense of recommending priority to certain breeds and then in fact limiting importation permits to these and to applicants who meet certain standards in terms of their breeding programs. The other approach is to throw the applications into a hat, draw out the required numbers, and declare the winners! Suffice it to say that I feel strongly that if importation policy is defined as it should, to improve our

future livestock industry through this medium, then consistency would call for a broad plan, developed on the basis of breeding principles and geared to providing all technical knowledge available to maximize the longterm benefits from this exercise. If decisions are to be significantly influenced by political pressures, real or anticipated, then the utility of the program will fall considerably short of what it could be.

In keeping with the above concept, one would have to assume that the beef industry, as a national resource, and one which in the future will depend more and more on its competitive position, should be subject to some direction, or restraints, which might differ from its self-imposed restraints as a completely free enterprise where concern for the immediate rather than the more distant future is likely to dominate.

The burden would be placed on those who are required to develop and administer the importation policy to continuously examine it and revise it where necessary in this light. Its effective use would tend to further underline areas where more research is required. Whatever importations of stock are made, it is obvious that improvement of breeds or lines will have to be continued by selection as well as through planned combinations of breeds and, possibly, synthesis of new lines. Thus, the scope of the importation program should relate to the capacity of the industry to utilize the genetic material. The industry will need to be structured so it can handle these programs.

In planning for effective breed utilization (in this I include not only foreign but also domestic breeds), one of the most critical questions would seem to be a definition of the traits of importance at present and with future potential significance. In certain new breed combinations or as a result of use of different mating systems, certain traits may take on changed significance. Examples of these could include the factors that contribute to ease of calving, particularly in medium-sized female lines mated to specialized high growth sire lines. Here we have the possibility of an undesirable interaction between traits at extremes of the performance range. We may need to know much more about genetic differences in traits previously not considered as very important, such as size of pelvic opening, gestation length, and the influence, if any, of the fetus in initiating parturition. The pressure will be on to identify some of these traits through research. The number of these important traits and their relative economic significance will likely affect the numbers of breeds considered necessary for importation. Our planning for the future beef industry will need to take account of the production systems which will likely be involved. Range production of beef cattle will no doubt be with us for a long time, but there is also

little doubt that, as we have known it, it will form an increasingly smaller percentage of the total beef production. Thus, different genotypes may be called for by these different systems. Couple with this the possibility that the calf may be raised more economically on other than milk from the cow, and that this cow will need to be one which, in a high frequency of cases, can produce at least two calves rather than one, and we see some of the situations for which we need to be prepared. Since we do not know clearly yet how these trends will develop, a partial answer lies in retaining "genetic flexibility", that is the capacity to search for and utilize breeds to fill specific needs; but, again, we should define the needs!

While we may not be able to identify all the traits of future importance in beef cattle breeding, it is obviously highly urgent to try to obtain and assess comparative performance data on traits recognized as important in the breeds proposed for importation. Available scientific literature on these breeds should be examined for what it can contribute. We should not, in our enthusiasm over foreign imports, overlook what our own domestic breeds have to offer. What is the evidence, for example, that for the production of specialized female lines, either for specific single crosses or for a rotational system, we can improve on the breeds already available on this continent? We can really only answer this question when we know what we should be looking for in these lines. This puts the problem right back into the research area; and an important part of this research may be economic as well as biological.

In an importation program, at best costly, and necessitating making choices between breeds, the possibility of setting up specifically-designed testing programs (in the countries of origin) to evaluate prospective breeds should at least not be overlooked. It is recognized that this could be complicated if involving more than one country. On an even broader basis, the value of such a program in its implications for international development could at least be considered. Assuming a departure from free enterprise (i.e., preference based on some decision-making will be given to certain breeds), the question immediately arises as to what breeds should be imported and how priorities should be established. This will need to be based on a comprehensive assessment using the criteria and the procedures already discussed. It should be mentioned that in selection within breeds for importation, to date, not all available records have been fully utilized.

If the recognized objective is to maximize the contribution of imported breeds, the following procedures are proposed.

(a) Use of the facility should be devoted to a minimum number of breeds at any one time and to building these up as rapidly as possible within the industry; this is as opposed to a "free choice" system. I suggest that the exploitation concept in regard to the imported breeds, which is dominant in the current philosophy of the industry, is not in itself conducive to the best animal breeding practices, although healthy economic advantage of their use is obviously important. The present importers cannot afford to practice culling. It would be desirable to remove some of the glamour and "gobbledy gook" which surrounds this procedure and get down to the pedantic business of manipulating genes for the purpose of maximizing production of lean beef. Thus space in the importation facility should be allotted to a sufficiently limited number of recommended breeds to provide an adequate sample of the genes of each for evaluation. When that point has been reached, preference should be given to other breeds. Thus, use of the facility should be restricted to those breeds which are considered to have the most promise, based on a continuing assessment of industry developments and needs utilizing all the evidence available.

(b) In conjunction with the decision to limit the number of breeds at any one time, it is suggested that, for distribution to the industry, bulls only should be imported; these would obviously be most effectively utilized through artificial insemination. This would mean that the industry would be committed to a system of backcrossing for building up herds with the desired percentage of the introduced genes. Because import facilities are restricted, importation of purebred females would not permit buildup of herd numbers to adequate levels any more rapidly than a backcrossing program; I suggest that female importation has other disadvantages in terms of the exploitation and the political pressures which it generates by the very fact that certain producers acquire prior advantage over others to produce purebred stock while it is still selling at unreal prices. Furthermore, it is not evident that bringing in pure females, as opposed to backcrossing, has any advantage whatsoever in achieving the goal of developing viable herds of a size necessary for effective selection. Herd buildup through backcrossing is presently a major factor in the establishment of new breeds. It could just as well be the only means. What is a reasonable number of bulls to sample a breed? Some arbitrary decisions may be needed, depending on various circumstances relating to the importation. I would suggest a minimum number of 30 bulls and a maximum of 50.

(c) If importation of females is considered this should be only as a single research herd. This could pose a problem of disposing of surplus females. This herd might be used to measure important differences in performance, under commercial

conditions, or to assess physiological differences. The importance of this purebred evaluation is proposed as secondary to testing the performance of F1 progeny of the breed; it should be considered only for the more promising breeds.

(d) An importation policy should include a plan to rapidly evaluate the imported breeds for their crossing ability with other breeds. It is highly desirable to try to build this into the total importation plan to provide objective comparisons as early as possible. One could question admitting breeds into the country without a reasonably critical means of evaluating evidence of their worth and their potential for commercial beef production. There should be concern for more than giving a few of the early buyers a chance for some quick financial gains. Testing and comparison of these breeds can be done by research establishments themselves; this is the ideal way for those organizations which are of sufficient size. It can also be done in industry, under direction of research scientists and supervised by trained field staff, by means of adequately designed tests conducted in private contract herds. Unless this research is done, it will be very difficult to obtain valid comparative information on some of the more important traits in projecting the future role of these breeds.

(e) Another useful approach will be if breed associations undertake programs of breed assessment and improvement. These will likely be within-breed improvement programs, such as the Conception to Consumer program of the Canadian Charolais Association, which has now been expanded to include the Simmental breed. The important principle is that these are producer groups engaged in breed improvement programs of their own.

(f) The breed importation program should be identified and recognized as part of an overall livestock improvement plan for the country. The technical aspects of the plan should be developed by a committee or board consisting primarily of animal geneticists and other personnel concerned directly with livestock improvement programs. Animal health decisions should make for a safe importation program but beyond that they should not compromise the decisions of the committee. This committee should have the function of making final decisions on foreign breed importation and allocation and should be familiar with or preferably involved in any other improvement programs which exist. Ideally, allocations of breeding stock to different areas of the country should be related to livestock improvement programs underway in those areas and the potential for such stock. This board or committee would concern itself also with the means whereby evaluation data on the imported breeds could be obtained.

In all the fervor of breed importation that exists at the present time, we should have answers to a number of questions. How many breeds should be imported and with what urgency? The answer is not entirely clear. The question relates, in part, to how many breeds or lines can be effectively handled in any breeding system developed in the industry at any time. If we have identified growth rate as the main desirable trait in certain foreign breeds, these, then, are prospective sire or terminal lines. How many, then, do we need? Are four better than two, and six better than four? Should we be considering any more than these and, if so, why? I suggest that we should be thinking out the answers, which involves, mainly, determining how these breeds should be used. The importation program should relate to the means for maintaining and improving these breeds. In addition, should you select certain breeds, perhaps of moderate growth rate, as prospective components of female lines? How do you identify these? What traits do you look for and within what range of expression? What will your mating system be whereby you utilize these breeds?

There are some answers, or good hunches, relating to these questions. It is unlikely that we have the final answer for any, but it behooves us to proceed with the importation, testing and utilization of foreign breeds as their worth is indicated and in keeping with our capacity to handle them. There are good indications, that many of these breeds will be used constructively for what they have to offer. It is important, however, to supplement, as quickly as possible, the present evidence of their merit with additional information on their effective utilization.

The fact that the quarantine procedure is the only way in which foreign breeds from certain countries can be obtained can be used as a legitimate means of providing direction to an industry, if we subscribe at all to the principle that an industry should be guided, in order to help to assure its future. I propose that this is a valid function and does not need to be considered an infringement of an individual's rights. If this is not acceptable, then the system of "random choice" already mentioned is the only alternative.

If the principle of directing the program is accepted, the test will be how the facility is administered and the plan that is developed from it. Choice of initial breeds will be relatively easy; later decisions between breeds will be more difficult. There is merit in a policy of a controlled testing program for additional breeds which can do a better job, but the complexity of such a program has been mentioned. Some of these breeds will, and should, be discarded or at least identified as to their degree of economic merit, hopefully more clealry than often is the case now. But I think it is

clear that the breed evaluation is only part, and perhaps, in its initial stages, the simplest part, of a total breeding system which will be necessary to keep beef production as a viable procedure of protein production in the 70's.

Now I wish to describe briefly the foreign breed evaluation program of the Canada Department of Agriculture Research Branch. Samples of two breeds were purchased by the Branch at the time of their first importation into Canada through Grosse Ile. A group of Simmentals, or Pie Rouge, were brought to the Lacombe Research Station in 1967 and a similar sample of Limousin came to the Brandon Research Station in 1968. The numbers were supplemented with additional females in each breed purchased in 1969. A program of evaluation, similar at both Stations, is designed to provide some limited information on the imported pure breeds but major emphasis is put on evaluating the F_1 progeny from crosses with the three British breeds, Hereford, Angus and Shorthorn. In these evaluations the Charolais breed is crossed along with the Simmental and Limousin with the same breeds to provide a basis for comparison. The F_1 progeny are produced by contracting with private herds in which matings are made, all by artificial insemination, utilizing semen from each of the three breeds and, thus, producing nine different breed crosses. In the current year semen from 10 to 12 bulls per breed will be used.

Data are being obtained on birth weights, gestation length, ease of calving, preweaning, feedlot and carcass traits of males, and on reproductive performance of the crossbred females. Calves are bought at weaning from the cooperators for the postweaning test at the Research Stations. The evaluation project for one breed will be carried over several years. As part of this program, it is planned to evaluate samples of the female crossbred groups under range conditions in the Lethbridge Research Station program. The numbers projected for evaluation of each specific breed cross are about 100 of each sex. The plan is to use three breeds of terminal sires on each group of crossbred females.

At present the C.D.A. Research Branch has not made specific plans for evaluating additional foreign breeds. The need for the information is recognized. Decisions on priority of programs, and on breeds for testing will continuously come up, as the facilities required are fairly extensive. There is also, somewhat ironically, some problem in obtaining contract herds in view of competition from breeders who are interested in their use to build up the imported breeds as quickly as possible. Another demand for these herds is in the testing programs such as of the Charolais Association.

Information from the breed evaluation program is released on a preliminary basis to the industry as it is gathered to provide for an early indication of the important traits associated with these breeds, such as birth weight of calf in relation to ease of calving. Suffice to say that there is a great deal of interest in this information, and, in addition to its direct use, it helps provide for a better channel of communication with industry. An evaluation program such as this, while obviously quite applied, will provide the industry with comparative information of a nature which it could not otherwise obtain, thus helping to dispel a lot of possible conjecture and misunderstanding. The justification of this work being done by research stations may continue to be debated by some. The answer must be arrived at in deciding what are the most pertinent problems of the industry they serve and the means available for dealing with them.

In brief summary, I have identified some ways in which I think a breed importation program can be used to maximize the real benefits to the industry in producing beef more cheaply. Some of the emotion and glamour being built around the new breeds does not fit with this concept; these should be replaced by objective results and proposals for breed utilization. What we must be concerned about is keeping the beef industry in business, and in this we must consider the future industry as well as that presently in existence. The future is bright if developed on the basis of goals which emphasize productive efficiency. The new breeds provide a stimulus and one approach in reaching these goals.

REPORT TO REGIONAL TECHNICAL COMMITTEES

Estel H. Cobb
Cooperative State Research Service

Changes in CSRS Personnel

On June 30, 1970, Dr. H. C. Knoblauch retired after 35 years of Federal service, 30 of them being in CSRS. He has been associate administrator for the past several years. Trained as a soils scientist, Dr. Knoblauch has had a distinguished career of service to science and agriculture.

Revision of Manual of Procedures

CSRS-OD-1082, Manual of Procedures for Cooperative Regional Research, was revised, effective January 1970. Copies have been sent to all station directors. If anyone needs additional copies, please let me know.

Summary of Status of Fiscal 1971 Appropriations (H.R. 17923) as of June 29, 1970

	Appropr. 1970	President's 1971 Budget	House bill 6-4-70	Senate Report 6-29-70
Hatch				
Payments to States	$53,756,941	$62,399,641	$56,861,911	$59,771,911
Administration	1,432,059	1,699,359	1,528,089	1,618,089
Total	55,189,000	64,099,000	58,390,000	61,390,000[1]
McIntire-Stennis	3,785,000	4,412,000	4,012,000	4,412,000
Facilities	1,000,000	0	0	0
Contracts and grants	2,000,000	3,350,000	2,000,000	3,350,000
Penalty mail	160,000	160,000	160,000	160,000
Federal Admin.-other	376,000	514,000	514,000	514,000
Total CSRS	$62,510,000	$72,535,000	$65,076,000	$69,826,000

1 Includes $3,201,000 for increased cost of conducting research and $3 million for Community Improvement Res.

Joint committee of House and Senate is now working on final version.

International Quarantine Station

Public Law 91-239 was approved on May 6, 1970. The purpose of the act is to provide for the establishment of an international quarantine station and to permit the entry therein of animals from any country and the subsequent movement of such animals into other parts of the United States for purposes of improving livestock breeds, and for other purposes (formerly S. 2306).

Changes in Regional Research Projects Related to Genetics and Animal Breeding

The Western regional beef cattle breeding project (W-1) was terminated, effective June 30, 1970. A Western Regional Coordinating Committee for Beef Cattle Breeding Research (WRCC-1) has been authorized by the Western Directors for a three-year period starting July 1, 1970, with Martin J. Burris (Montana) as administrative advisor.

A new Western regional research project entitled "Reproductive Performance in Beef Cattle (W-112)" was initiated July 1, 1970. Rue Jensen (Colorado) is administrative advisor.

A new Northeastern regional research project entitled "Control of Reproduction in the Bovine Female (NE-72)" has been approved with R. J. Flipse (Pennsylvania) as administrative advisor.

Termination Report of W-1

and

Report of

Annual Meeting of W-1/WRCC-1 Technical Committee

U. S. Meat Animal Research Center
Clay Center, Nebraska

August 10-12, 1970

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PART II

PERSONNEL

Project Leaders

Carl B. Roubicek*	Arizona
Wade C. Rollins*	California
J. S. Brinks*	Colorado
Diedrich Reimer*	Hawaii
R. E. Christian*	Idaho
R. L. Blackwell*	Montana
C. M. Bailey* (Chairman)	Nevada
L. A. Holland*	New Mexico
Ralph Bogart*	Oregon
J. A. Bennett*	Utah
C. C. O'Mary*	Washington
G. E. Nelms*	Wyoming
O. F. Pahnish*	U.S. Range Livestock Experiment Station
Keith E. Gregory**	U.S. Meat Animal Research Center
Gary Richardson**	U.S. Biometrical Services

Administrative Adviser

Martin J. Burris	Montana

Agricultural Research Service

Bradford W. Knapp*	Acting Investigations Leader
Paul A. Putnam	Chief, Beef Cattle Research Branch

Cooperative State Research Service

Estel H. Cobb	Assistant Administrator

* W-1 and WRCC-1 Committee Member
** WRCC-1 Committee Member Only

W-1 TERMINATION REPORTS

UNIVERSITY OF ARIZONA

I. Station: Arizona Agricultural Experiment Station

II. Project titles: 1. Progeny testing of Hereford sires.
2. Breeding and selection of beef cattle for the southwest.
3. Progeny testing of selected Hereford sires.

III. Personnel:

Experiment Station:
C. B. Roubicek, Project Leader, R. C. Collins, L. W. Dewhirst, P. H. Diven, E. S. Erwin, W. H. Hale, F. E. Hubbert, F. Kiernat, A. M. Lane, G. E. Nelms, A. F. Pahnish, D. E. Ray, R. M. Richard, R. L. Roberson, C. E. Safley, E. B. Stanley, B. P. Taylor, P. E. Taylor, R. L. Taylor, R. E. Watts, F. V. Van Wilson, and T. C. Wheeler.

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado:
Bradford W. Knapp, Acting Investigations Leader

IV. Major accomplishments:

The W-1 contributing project of the Arizona Station was initiated in 1947 as a cooperative project with the Boice ranches at Sonoita and Arivaca. Performance records were obtained including individual animal weights and scores at weaning and 18 months of age. Prospective replacement herd sires were placed on feed test with final selection at the conclusion of the test. A major consideration at this time was the development of a suitable selection index for replacement bulls and heifers. It was determined that weaning weights could be accurately adjusted for a 90-day range. A detailed evaluation of conformation scores used in the selection of replacement heifers was reported. It was noted that the simple correlation of scores by three judges was about 0.5. It was concluded that a selection index should consider animal weight as the major factor with score being used to determine if the animal was of acceptable beef type. It was also established that average daily gain on feed test was highly correlated with feed per unit gain and with an efficiency quotient (Table 1).

Table 1. Correlations of average daily gain on feed test with feed efficiency (bulls).

Average daily gain with:	180-day time constant	condition constant
Feed per lb. gain	-.73	-.96
E. Q.	+.92	+.95

E. Q. (Efficiency Quotient = $\frac{\text{Total gain}}{\text{Total D.M. consumption}}$ x mean live weight

This information indicated that selection on the basis of average daily gain on feed test would also improve the efficiency of feed utilization as a correlated response.

A summary of the weaning data obtained from the Boice ranches showed that a linear correction would be applicable for an age adjustment. The regression for bulls was 1.442; for heifers 1.090. Age of dam correction for 3 year old cows was 50 lb. for bull calves and 24 lb. for heifers.

Heritability estimates of weaning traits for bulls and heifers are presented in Table 2. Analysis of variance indicated that year effects accounted for approximately 11 and 16 percent of the variation in weaning weights of bull and heifers calves, respectively, after weights were adjusted for differences in weaning age and age of dam.

Table 2. Heritability estimates of weaning traits for bulls and heifers at Boice ranches.

	Heritability	
Trait	Bulls	Heifers
Weaning weight	.28	.57
Conformation score	0	.39
Condition score	0	.24

The phenotypic correlations among weanling traits are shown in Table 3. Heifer calves tended to vary less and score higher than did bull calves. The high positive correlation between conformation and condition scores indicates that either score would be suitably descriptive.

Table 3. Phenotypic correlations among weanling traits of bulls and heifers.

	Condition score		Actual weaning weight		Adjusted weaning weight	
Score:	M	F	M	F	M	F
Conformation	.[illegible]2	.70	.20	.37	.28	.42
Condition			.52	.60	.54	.57

The dwarf research program, started in 1948, was initially concerned with establishing the immediate cause of dwarfism in the Hereford breed. By use of a dwarf breeding herd and other controlled matings it was determined that the dwarf trait was conditioned by an autosomal recessive gene. The variation in phenotypic expression of the dwarf trait in newborn and young calves was delineated in order to establish the basis of an accurate progeny test procedure for use by industry. These research findings were utilized by the industry as the most effective method to control the dwarf problem.

In 1957 the Arizona Station entered into a cooperative agreement with the Apache Tribe at San Carlos for cooperative research with the 600 cow Registered Hereford Tribal herd. In addition to performance data, blood and liver samples were obtained for a four year period for all progeny at weaning, yearling, 18 and 24 months of age. Constituent data for 700 to 1000 animals per trait with 24 to 30 sires represented were statistically evaluated. The study included a total of over 40,000 laboratory analyses. Heritability estimates are shown in Table 4. The analysis of variance consistently indicated that year effect was the largest single source of variation. Since these animals were unsupplemented and depended solely upon range forage it appears that nutritional status is an important source of variation in all traits measured.

Heritability estimates of hepatic carotene and vitamin A differed appreciably among sampling periods. Hepatic vitamin A estimates were consistently larger following periods of storage as contrasted to depletion periods. Heritability estimates for plasma carotene concentrations were higher for male progeny and showed greater values after periods of high carotene intake. Estimates for plasma vitamin A concentration showed little evidence of genetic influence.

Heritability estimates of plasma cholesterol concentration were highly variable between the sexes and among sampling periods. Estimates of 0.46 and 0.37 for female progeny at weaning and 600 days of age; respectively, were the only significant indications of genetic influence of this constituent.

Table 4. Heritability estimates of blood and liver constituents of beef cattle at four ages.

	Age (days)							
	235		340		600		710	
	M	F	M	F	M	F	M	F
Hepatic:								
Vitamin A	.36	.77	.03	.38	.79	.76	.48	.32
Carotene	.14	.40	.02	.70	.12	.52	.20	.31
Plasma:								
Vitamin A	.19	.14	*	.13	.17	*	*	.04
Carotene	.43	.28	.13	.16	1.05	.27	.50	.22
Cholesterol	.16	.46	.10	*	*	.37	.15	.04
Phosphorus	.03	.04	.10	.08	.13	*	.32	.03
Blood:								
Hemoglobin	.22	.27	.04	.10	.25	.30	.16	.20
	M + F		M + F		M + F		M + F	
Creatinine	.06		.10		0		*	
Uric acid	.04		.06		.07		.14	

* Negative sire component.

Plasma phosphorus concentration was highly subject to environmental influences as indicated by low heritability estimates. Heritability estimates of blood hemoglobin were also in the low range but were generally higher following periods of good nutrition. Heritability estimates of blood creatinine and uric acid concentrations were essentially zero at all four sampling periods.

The correlations among hepatic and blood constituent concentrations at the four sampling periods are shown in Table 5.

Table 5. Correlations among hepatic and blood constituent concentrations at four ages.

Constituent at age:	Mean age (days)			
	235	340	600	710
Hepatic carotene:(1)				
235	-	0.29	0.32	0.44
340	0.40	-	0.41	0.37
600	0.22	0.37	-	0.33
710	0.24	0.29	0.05	-
Hepatic Vitamin A:(1)				
235	-	0.53	0.25	0.20
340	0.55	-	- .11	- .16
600	0.47	0.21	-	0.39
710	0.4[illegible]	0.1[illegible]	0.[illegible]	-
Plasma carotene:(1)				
235	-	0.40	- .06	- .07
340	0.43	-	- .30	0.10
600	- .09	- .03	-	- .17
710	- .20	- .33	0.43	-
Plasma Vitamin A:(1)				
235	-	0.25	0.20	- .10
340	0.58	-	0.02	- .32
600	0.13	0.04	-	0.17
710	0.11	- .05	0.46	-
Plasma cholesterol:(1)				
235	-	0.00	0.45	- .15
340	0.10	-	- .07	0.12
600	0.37	0.07	-	- .18
710	- .41	- .20	- .11	-
Hemoglobin:(1)				
235	-	0.1[illegible]	0.08	- .14
340	0.29	-	0.27	0.01
600	0.09	0.21	-	- .04
710	- .03	0.22	- .01	-
Plasma phosphorus:(1)				
235	-	0.03	- .02	- .13
340	0.01	-	0.19	0.13
600	0.04	- .05	-	0.00
710	0.02	0.31	0.10	-
Blood creatinine:(2)				
235	-	- .02	- .04	0.13
340	0.19	-	0.22	0.12
600	- .03	0.32	-	0.04
710	0.49	0.09	0.15	-
Blood uric acid:(2)				
235	-	- .0[illegible]	- .09	0.08
340	0.21	-	0.07	0.05
600	0.45	0.72	-	0.10
710	- .2[illegible]	0.4[illegible]	0.33	-

(1) Correlations for males above diagonal; for females below diagonal.

(2) Correlations above diagonal are calculated from total sums-of-squares and crossproducts; those below the diagonal from residual

Table C. Correlations of hepatic and blood constituents at four ages with contemporary and subsequent growth traits.

Constituent at age:	Weight at age 235 M	235 F	340 M	340 F	600 M	600 F	710 M	710 F
Hepatic vitamin A:								
235	0.22	0.22	0.20	0.14	-.11	0.13	-.01	-.21
340	-	-	0.16	-.14	-.20	0.28	-.33	-.10
600	-	-	-	-	-.11	-.09	0.04	-.32
710	-	-	-	-	-	-	0.02	-.43
Hepatic carotene:								
235	-.0[illegible]	-.09	0.26	0.17	-.16	0.00	0.02	-.39
340	-	-	0.20	0.14	-.20	-.13	-.14	-.17
600	-	-	-	-	-.07	-.31	0.14	0.11
710	-	-	-	-	-	-	-.12	-.20
Plasma vitamin A:								
235	-.07	-.14	0.05	0.01	0.02	0.03	-.02	0.00
340	-	-	0.26	0.10	-.20	-.02	-.14	-.02
600	-	-	-	-	0.33	0.24	0.13	0.25
710	-	-	-	-	-	-	0.17	0.35
Plasma carotene:								
235	0.13	0.04	0.36	0.22	-.16	0.00	-.21	-.15
340	-	-	0.19	0.04	-.34	0.04	-.23	-.08
600	-	-	-	-	0.44	0.09	0.18	0.40
710	-	-	-	-	-	-	0.03	0.14
Plasma cholesterol:								
235	-	-	-.30	-.19	0.24	0.05	0.31	0.20
340	-	-	-	-	0.07	-.15	0.05	-.08
600	-	-	-	-	-	-	0.09	0.20
Hemoglobin:								
235	-.20	0.03	-.08	-.04	-.01	0.06	0.11	0.03
340	-	-	0.18	0.06	-.21	-.02	-.16	-.15
600	-	-	-	-	-.17	0.04	-.16	-.14
710	-	-	-	-	-	-	0.09	0.10
Plasma phosphorus:								
235	-.11	-.13	0.07	-.07	-.07	-.02	-.05	-.13
340	-	-	-.02	0.04	0.05	0.16	0.05	0.39
600	-	-	-	-	0.13	0.01	-.05	-.05
710	-	-	-	-	-	-	0.25	0.22

	235 M + F	340 M + F	600 M + F	710 M + F
Creatinine:				
235	0.07	0.13	-	-
340	-	-.56	-.66	-
600	-	-	-.02	-.02
710	-	-	-	-.08
Blood uric acid:				
235	-.04	-.04	-	-
340	-	0.09	0.32	-
600	-	-	0.23	0.25
710	-	-	-	-.13

The correlations for the various constituents are generally low, indicating that environmental influences are important in determining individual values. Some of the correlations for adjacent sampling periods, especially for hepatic and plasma vitamin A and carotene, are significant and indicate some carry-over effect of previous concentration.

The correlations of hepatic and blood constituents with contemporary and subsequent animal weights are presented in Table 6. The correlations of hepatic carotene and vitamin A tend to be low and of little or no predictive value. The correlations of plasma carotene and vitamin A are highly variable. The males do show a tendency for improved weight performance with higher levels of plasma carotene. The correlations between cholesterol concentration and subsequent weight tend to be low and not large enough to be useful for predictive purposes. Also, there was no consistent association of hemoglobin concentration and weight. The correlations of plasma phosphorus level with growth traits were very low, indicating that even under conditions of nutritional stress the plasma levels of phosphorus were adequate to meet the growth needs of the animals. Correlations of -.5[illegible] and -.6[illegible] for 340-day creatinine blood concentration and weight at 340 and 600 days of age, respectively, indicates that the increased blood creatinine values resulting from the nutritional stress of the wintering period were negatively associated with contemporary weight and subsequent gain performance.

Plasma levels of carotene have been traditionally used as a measure of vitamin A status of range beef cattle. The correlations of plasma carotene values with hepatic levels of vitamin A and carotene are shown in Table 7. The results indicate that plasma carotene should be used with caution in attempts to evaluate the vitamin A status of cattle. Low plasma levels of carotene are evident only when the liver is at the depletion point.

Table 7. Correlation of plasma carotene values at four ages with contemporary Hepatic Vitamin A and carotene and plasma vitamin A

	Hepatic		Plasma
	Vitamin A	Carotene	vitamin A
Plasma carotene:			
235	0.27	0.3[illegible]	0.54
340	0.27	0.40	0.[illegible]0
600	0.12	0.29	0.20
710	0.29	0.51	0.49

The initial phases of the growth and reproductive performance research conducted with the San Carlos Tribal herd included the construction of 12 single sire breeding pastures. In 1957 two sires from each of Miles City lines 1, 6, 9 and 10 were used together with selected sires raised in the Tribal herd. In addition to birth weight, weights, condition and conformation score were taken at 235, 340, 600 and 710 days of age. An analysis of three calf crops indicated that progeny of line 1 and line 9 sires averaged above the herd average in both 235- and 600-day weights. The progeny were slightly below average in conformation score. Topcross progeny from lines 1, 6 and 9 were included in a study with progeny of San Carlos herd sires (designated SC). The experimental design permitted a comparison among all possible topcross and SC matings for a total of four years. A summary of the comparisons of topcross sire and dam lines is shown in Table 8.

Table 8. Comparisons of topcross sire and dam lines with controls (SC X SC) by deviations from least squares means.

Comparison		Variable				
Sire line	Dam line	Birth weight	Weaning weight	Daily gain, birth to weaning	Conformation score[a]	Condition score[a]
		kg	kg	kg	units	units
SC X	SC	0.36	0.09	-.001	0.13	0.06
vs.						
1 X	SC	-.13	-1.21	-.002	-.19*	-.35*
6 X	SC	0.76	-4.58	-.016	-.20	-.31
9 X	SC	-.33	-3.71	-.015	-.18	-.08
SC X	1	1.18	5.89	0.019	0.24	0.21
SC X	6	0.26	16.08**	0.062**	0.58**	0.21
SC X	9	0.97	-5.72	-.026	0.05	0.04

[a]Evaluated on a 15 point scale, with higher values indicating more desirable conformation or higher condition.

* $P < .05$.
** $P \leq .01$.

The results of the study shows that dam line exerted a greater influence on preweaning growth than sire line, whereas birth weight and conformation score were influenced more by sire line. Significant differences within lines for growth traits were noted when calves were classified by sire line vs. dam line. Calves with the highest weaning weight by dam line had the lowest weaning weight by sire line. Conversely, calves with the highest sire line weaning weights were among the lowest by dam line. In this particular herd, the use of topcross dams from the lines evaluated resulted in a definite improvement in preweaning growth, although topcross sires offered no advantage.

These data suggest that maternal ability is more important in determining weaning performance than differences in genetic growth potential. A negative relationship between maternal ability and growth potential is indicated on a between line basis.

The San Carlos Tribal herd has been managed under a system of year around grazing without supplementation. Summer rains provide adequate range forage during the summer months, however, forage is generally inadequate during the winter period from December to May. This period of nutritional stress results in substantial animal weight loss which must be recovered during the following summer. This system provided a unique opportunity to determine the genetic parameters of growth during stress and the subsequent compensatory gain. Animal weights, condition and conformation scores were taken on all animals in the fall at weaning, during early spring at the end of the winter stress period, the following fall at the end of the summer grazing season and again the following spring. During this 2-year period all animals were retained in the herd.

Heritability estimates of these traits are listed in Table 9. The estimates generally show increasing values as the animals become older. The heritability estimates of weight and gain are sufficiently large to permit substantial genetic progress in selection for these traits. The genetic and phenotypic correlations of the growth traits are shown in Table 10. The predicted response to direct selection and the correlated response of other growth traits is shown in Table 11. These data indicate that under conditions of periodic nutritional stress genetic selection for improved weight performance is most effective if delayed until fall yearling age. It also appears that heifers are less effected by environmental stress than are bulls, therefore a progeny test should be more accurate if evaluated by heifer progeny performance.

The final report of the Line Test project cannot be included at this time since complete data are not yet available. A summary of the feed test performance of sample progeny from the line test sires is presented in Table 12. Range performance of the half-sibs has not been completely summarized. The evaluation of reproductive performance of the heifer progeny cannot be completed for several years.

The work at San Carlos has also included several concurrent studies with the herd. This includes the evaluation of range supplementation to improve reproductive performance of second-calf heifers. Preliminary results suggest that supplementation alone is not of direct benefit. A study of animal parasites has shown that cattle lice caused enough damage to account for a loss of 30 pounds of body weight per animal. The lice removed as much as [illegible]0 percent

of the red blood cells from two-year-old heifers and 77 percent from bulls. This resulted in anemia and lowered resistance of the animals to other types of diseases. Trials with various types of systemic compounds with preweaning calves showed that animals as young as two weeks of age could be safely treated with almost 100 percent control of cattle grubs. The treated animals also showed improved pre-weaning gain performance.

Table 9. Heritability estimates from paternal half-sib correlations

Trait[a]	Estimates: Bulls	Estimates: Heifers
Birth weight	0.32	0.14
Gain, birth to weaning	0.01	0.25
Weaning weight	0.05	0.23
Weaning grade	0.08	0.24
Weaning condition score	0.06	0.32
Gain, birth to end of first winter	0.11	0.20
Gain, weaning to end of first winter	0.32	0.16
Weight, end of first winter	0.20	0.21
Grade, end of first winter	0.04	0.13
Condition score, end of first winter	0.17	0.16
Gain, birth to fall yearling age	0.51	0.43
Gain, weaning to fall yearling age	0.57	0.32
Gain, end of 1st winter to fall yrl. age	0.49	0.32
Fall yearling weight	0.64	0.40
Fall yearling grade	0.16	0.13
Fall yearling condition score	0.31	0.11
Gain, birth to end of second winter	0.82	0.49
Gain, weaning to end of second winter	0.71	0.43
Gain, end 1st winter to end 2nd winter	0.52	0.38
Gain, fall yrl. age to end 2nd winter	0.20	0.52
Weight, end of second winter	0.87	0.52
Grade, end of second winter	0.18	0.31
Condition score, end of second winter	0.13	0.53

[a]Gains refer to daily gains. Grades, scored on fifteen point basis, were committee averages. Condition scores, on fifteen point basis ranging from excellent to poor, were committee averages.

Table 10. Genetic (G), Environmental (E) and Phenotypic (P) Correlations Among Growth Traits of Heifers (Upper Right) and Bulls (Lower Left)[a]

Item		Birth wt.	ADG, pd. 1	Wean. wt.	ADG, pd. 2	Weight after stress	ADG, pd. 3	Fall yrl. wt.
Birth wt.	G	. . .	0.30	0.42	0.30	0.48	-.20	0.17
	E	. . .	0.18	0.42	-.18	0.32	0.37	0.41
	P	. . .	0.20	0.42	-.10	0.35	0.24	0.34
ADG, pd. 1	G	1.98	...	0.90	0.04	0.97	0.30	0.83
	E	0.01	...	1.13	-.37	0.70	0.14	0.60
	P	0.09	...	1.08	-.31	0.74	0.21	0.67
Wean. wt.	G	1.12	1.70	...	0.02	0.89	0.21	0.82
	E	0.22	0.94	...	-.28	0.89	0.46	0.65
	P	0.31	0.94	...	-.23	0.89	0.38	0.71
ADG, pd. 2	G	0.41	----	0.21	...	0.63	-.14	0.15
	E	-.30	----	-.53	...	-.02	-.07	0.31
	P	-.09	----	-.42	...	0.10	-.09	0.30
Weight after stress	G	0.91	----	0.81	0.97	...	0.12	0.80
	E	0.10	----	0.90	-.37	...	0.55	0.73
	P	0.29	----	0.85	-.03	...	0.37	0.78
ADG, pd. 3	G						...	1.02
	E						...	0.02
	P						...	0.38

[a]Dashes indicate correlations omitted because of negative sire variance component for period 1 rate of gain in postweaning block of data. ADG is average daily gain. Pd. 1, 2 and 3 are gain periods between weights in order listed at top of table.

Table 11. Direct Selection and Correlated Response

	Birth wt.		Wean. wt.		Yrlng. wt.		Fall yrlng. wt.
	H	B	H	B	H	B	H
Direct selection for:							
Birth weight	1.37	3.04					
Weaning weight	.74	1.20	9.8	2.3	7.7	3.3	14.2
Yearling weight		2.30		3.8		8.1	
Fall yearling wt.	.40		10.0		9.2		22.8

Table 12. Summary of average daily gain on 140-day feed test of bull progeny from Line Test project

Sire Line	1967	1968	1969	1970
Colorado Brae Arden	2.84	2.86	3.46	3.17
Colorado Royal	3.11	3.15	3.27	3.12
Miles City L4	3.21	3.04	3.56	3.05
Miles City L14	3.09	3.09	3.34	3.00
Montana	2.89	3.13	3.26	3.05
Nevada Reno	3.02	2.88	2.89	2.84
Nevada KC	-	2.74	2.99	2.83
New Mexico	3.01	2.76	3.15	2.81
Utah	2.80	3.01	2.94	3.17
Wyoming	2.76	3.22	3.09	2.73
Other(1)	2.90	2.98	2.89	2.95

(1) Includes sample progeny of selected sires used at San Carlos.

Arizona Agricultural Experiment Station

Sire Summary - 140-day Test

Sire		N	ADG
103	Nevada 684	7	2.84
127	Bozeman 533	6	3.05
128	MC L4 (6236)	5	3.05
129	MC L14 (3114)	6	3.00
130	Brae Arden (5142)	7	3.17
131	Royal (6498)	4	3.12
132	Utah 1170	7	3.17
133	Nevada K458	4	2.83
134	Wyoming 86	6	2.73
135	New Mexico 515	5 (6)	2.81
	S. C. Bulls	12	2.95

Arizona Agricultural Experiment Station

140 Day Test Results

No.	DOB	Initial Wt.	Final Wt.	140 day ADG	Score Conf.	Score Cond.
			103 Nevada 084			
72	051	422	840	2.99	11	11
116	056	470	920	3.21	10	13
131	053	520	870	2.50	9	12
236	077	416	816	2.86	10	11
282	079	510	894	2.70	10	12
359	101	392	800	2.91	10	11
383	115	394	778	2.74	11	13
			127 Bozeman 533			
52	049	638	1062	3.03	12	11
238	075	434	880	3.19	11	12
290	080	446	860	2.96	11	12
312	085	496	958	3.30	12	12
339	084	480	840	2.57	9	11
345	095	500	954	3.24	11	12
			128 MC L4 (C230)			
124	057	590	1050	3.29	13	12
206	068	534	1014	3.43	12	12
230	075	456	874	2.99	12	12
283	080	448	822	2.67	10	11
388	080	394	796	2.87	10	11
			129 MC L14 (C114)			
109	055	4[illegible]	85[illegible]	2.79	11	12
150	059	490	876	2.76	11	12
156	059	506	924	2.99	11	12
190	065	540	1010	3.36	12	12
289	080	484	954	3.36	12	11
392	120	494	880	2.76	11	12

Arizona Agricultural Experiment Station

140 Day Test Results

No.	DOB	Initial Wt.	Final Wt.	140 day ADG	Score Conf.	Score Cond.
			130 Brae Arden (5642)			
22	042	508	910	2.87	11	13
77	052	590	1054	3.31	13	12
195	065	514	966	3.23	12	12
214	069	532	980	3.20	12	11
221	071	552	993	3.10	12	12
244	076	466	924	3.27	12	12
291	080	440	894	3.24	11	12
			131 Royal (1498)			
40	048	472	910	3.13	12	11
119	053	490	880	2.86	11	12
223	071	480	910	3.07	10	13
398	122	410	890	3.43	11	13
			132 Utah 117D			
74	051	530	910	2.71	11	11
137	058	504	930	3.04	11	11
252	076	506	970	3.31	11	13
331	092	474	966	3.51	13	12
377	115	440	944	3.60	12	12
397	122	470	870	2.93	10	11
407	128	380	810	3.07	11	12
			133 Nevada K 458			
76	052	462	840	2.70	11	12
132	063	466	882	2.97	11	12
321	091	500	914	2.96	12	12
351	102	396	770	2.67	10	11

Arizona Agricultural Experiment Station

140 Day Test Results

No.	DOB	Initial Wt.	Final Wt.	140 day ADG	Score Conf.	Score Cond.
			134 Wyoming 86			
113	056	500	874	2.67	10	12
161	060	530	890	2.57	11	11
229	074	484	892	2.91	11	12
269	077	5[illegible]0	1030	3.36	13	12
277	078	500	850	2.50	11	11
412	128	430	7[illegible]0	2.36	10	11
			135 New Mexico 515			
92	053	4[illegible]0	880	3.00	10	11
177	062	500	9[illegible]	3.33	12	12
208	069	4[illegible]	81[illegible]	2.50	10	10
232	075	480	8[illegible]0	2.71	12	11
267	077	4[illegible]0	774	*		
335	093	502	850	2.49	10	12

* had diptheria

No.	DOB	Initial Wt.	Final Wt.	140 day ADG	Score Conf.	Score Cond.
			S. C. Bulls			
524	051	544	944	2.86	11	13
544	057	5[illegible]4	986	3.01	13	12
557	060	420	910	3.50	10	12
616	078	470	8[illegible]0	2.79	10	12
657	092	4[illegible]0	906	3.19	11	12
659	092	380	7[illegible]0	2.71	10	11
660	092	372	770	2.84	10	11
706	099	370	800	3.07	11	11
761	112	452	894	3.16	12	12
779	113	410	780	2.[illegible]4	11	11
797	117	414	750	2.40	10	10
822	124	48[illegible]	930	3.17	11	12

Conformation and condition score:

10 = low choice

12 = high choice

V. Major Publications: (1969-1970)

Collins, R. C., L. W. Dewhirst and L. A. Carruth. 1969. The cattle grub problem in Arizona. I. Timing of adult activity of the common cattle grub. J. Econ. Entomol. 62(3):552-556.

Ray, D. E., C. B. Roubicek, C. F. Pahnish and J. S. Brinks. 1970. Breeding merit of topcross parents for preweaning traits in Hereford cattle. J. Animal Sci. 30(2):101-106.

Roubicek, C. B., D. E. Ray and W. H. Hale. 1970. Blood creatinine and uric acid concentrations in unsupplemented range cattle. J. Animal Sci. 30(5):675-680.

VI. Application of Results:

1. As a result of the research on identification and inheritance of dwarfism in the Hereford breed, industry leaders were able to modify their breeding programs to bring this problem under a measure of control.

2. With the knowledge that selection for increased growth also improved feed efficiency, procedures were established for genetic evaluation of feedlot and range growth performance. Heritability estimates and genetic correlations provided the necessary information to determine the relative economic importance of conformation and growth traits as selection criteria in beef cattle.

3. An extensive study of blood and liver constituents established the standard values and normal variation for growing range cattle. The data indicate that unsupplemented cattle may have critically low levels of vitamin A and phosphorus during the first winter period. Older animals appear to have sufficient reserves for all except prolonged drought conditions. It was also established that blood serum levels of vitamin A or carotene are not indicative of animal vitamin A status except when hepatic values are virtually depleted.

Heritability estimates for the various constituents are generally low, indicating that under the conditions of highly variable nutritional status, direct or indirect selection would not be effective in altering the blood values of these constituents. No useful correlations have been found between blood or liver components and growth performance.

4. The study of top-cross progeny performance shows that dam line exerted a greater influence on preweaning growth than did sire line. The dam line that produced calves with the highest average weaning weight had the corresponding sire line that produced calves with the lowest average weaning weight. It would appear that maternal ability is more important in determining weaning performance than differences in genetic growth potential. The data further suggests a negative

relationship between maternal ability and genetic growth potential. Because of the current popularity of using growth performance as the major criterion of beef cattle selection, it is especially important that this possible negative relationship be fully explored.

5. A large share of the regional effort in W-1 has been directed toward developing superior lines of beef cattle through inbreeding and intense selection. The cooperative project with the San Carlos herd has allowed the unbiased evaluation of the most promising lines and the identification of those lines of breeding which will be most beneficial in improving industry herds.

6. The general application of the W-1 research effort has been to lead the beef cattle industry from selection standards based upon arbitrary visual evaluation to selection criteria based upon sound economically important traits.

The necessity of maintaining performance records has also provided the cattlemen with important information for improving his management and marketing methods. The procedures involved with record of performance selection are conducive to better business practices.

UNIVERSITY OF CALIFORNIA

I. Station: California Agricultural Experiment Station

II. Project title: Bovine muscular hypertrophy - a study of its inheritance and an investigation of its usefulness to the beef industry (Project 2477).

III. Personnel:

Experiment Station:
W. C. Rollins, Project Leader, L. M. Julian, Moira Tanaka, and K. A. Wagnon

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado:
Bradford W. Knapp, Acting Investigations Leader

IV. Major Accomplishments:

Too early to report.

V. Major Publications: (1969-1970)

Rollins, W. C., L. M. Julian and F. D. Carroll. 1968. Double muscle segregants in an inbred line of Aberdeen Angus cattle. Proc. XII Int. Cong. Genet. Vol. I:276. Tokyo.

VI. Application of Results:

Too early to report.

I. Station: California Agricultural Experiment Station

II. Project title: (Project 1210):

(Former title) Breeding experiments to investigate the nature of genetic improvement in beef cattle productivity with special emphasis on the performance of inbred lines and their crosses.

(Later title) Studies of heterotic effects in crosses of the Angus, Hereford, and Shorthorn breeds.

III. Personnel:

Experiment Station:
W. C. Rollins, Project Leader, F. D. Carroll, K. A. Wagnon and R. G. Loy

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado:
Bradford W. Knapp, Acting Investigations Leader

IV. Major Accomplishments:

A. Formulation and elucidation of designs for and verification of the efficacy of performance testing beef bulls.

B. The design and execution of tests demonstrating significant amounts of heterosis in crosses of the British beef breeds.

V. Major Publications: (1969-1970)

Rollins, W. C., K. A. Wagnon, F. D. Carroll and R. G. Loy. 1970. Hybrid vigor estimates for the first backcross of a crisscross breeding system involving the Aberdeen Angus and Hereford breeds. Calif. Agric. Vol. 24, No. 5 (May 1970).

VI. Application of Results:

The California Beef Cattle Improvement Association in setting up its procedures for performance testing drew heavily upon the results and recommendations of the studies mentioned in Section IV, A. of this report.

Crosses between the Aberdeen Angus, Hereford and Shorthorn breeds are becoming increasingly popular in the production of market calves. This in part reflects the impact of recently published results of experiment station crossbreeding trials.

COLORADO STATE UNIVERSITY

I. Station: Colorado Agricultural Experiment Station

II. Project titles: 1. A study of selection, inbreeding, and crossing of inbred lines within the Hereford breed.
2. Comparisons of mating systems and mass selection in beef cattle production.

III. Personnel:

Experiment Station:
J. S. Brinks, Project Leader, Peter Fagerlin, John Childears, Warren Mangus, Gene Keller, and Pat Grapevine.

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado:
Bradford W. Knapp, Acting Investigations Leader

IV. Major Accomplishments:

1. Established phenotypic, environmental, and genetic parameters for traits related to reproduction, growth, mature size, conformation, feed efficiency, maternal ability, and carcass characteristics. Heritability estimates for semen characteristics were low being .14 for semen quality, .37 for concentration, .13 for vigor, .03 for percent alive, and -.06 for morphology. Heritability estimates for growth increase with increasing age from about 30% at weaning to 60% at maturity. Heritability estimates for rate of gain in the feedlot and carcass characteristics were high, being .64 for average daily gain, .36 for ribeye area, .52 for fat thickness, .40 for kidney fat weight, .42 for marbling score, and .70 for retail carcass value. Genetic correlations between daily gain and carcass traits indicate that selection for daily gain should increase carcass merit considerably through correlated response.

2. Established that increased inbreeding is associated with decreases in fertility, survivability, and early growth rate. The effect of inbreeding on growth decreases with increasing age of animal. The magnitude of the inbreeding depression varies widely with line and sex of calf. The effect of inbreeding of calf on weaning weight per percent increase in inbreeding was -.2288 lb. and -.4078 for heifer and bull calves, respectively. The corresponding effect of inbreeding of dam was -.7600 lb. and -.7118 lb. Inbreeding of dam appears to have a greater effect than inbreeding of calf on weaning weights.

3. Heterosis associated with linecrossing within the Hereford breed is important in semen characteristics, calf survivability and early growth rate. Heterosis for semen characteristics were 26.5% in morphology score, 4.3% in concentration, 9.5% in vigor, 7.4% for percent alive. Four groups of cattle, inbreds, linecrosses, controls, and crossbreds, showed 13.98, 7.46, 11.79 and 9.20% dying, respectively. Losses among linecrosses were 37% less than among controls. Heterosis in weaning weights was 15% for heifers and 8% for bull calves.

4. Prediction equations were developed for estimating cutability (closely trimmed steak and roast meat) in bull and heifer carcasses utilizing information on carcass weight, ribeye area, fat thickness, and kidney fat. Equations for predicting retail values were more accurate than those predicting weights.

5. A study on the effect of early, bunched calving in the optimum season indicates that lifetime production can be increased by calving early the first time. Calves born the first 20 days of the calving season averaged 17 days earlier and 41 lbs. heavier than the overall herd average. Most of the Weaning Weight advantage of early calves was due to the older ages at weaning but calves born earlier in the season also gained faster from birth to weaning which also added to their advantage. Cows were also grouped into 20-day intervals by the date of birth of their first calf. Cows that calved during the first 20 days of the calving season the first time continued to calve somewhat earlier and wean heavier calves throughout life. They calved 12 days earlier and weaned calves averaging 20 lbs. more than herd average during their productive life. For every 10 days earlier a dam's first calf was born, the total pounds produced per cow during her lifetime increased 32 lbs. based on an average of 4.7 calves per cow. Heifers conceiving the soonest after 15 months of age weaned older and heavier calves throughout life.

6. Factors affecting calving difficulty were studied. Of the 2971 births, 8.8% had some difficulty. There appears to be real differences among years which ranged from a high 15.5% calving difficulty in 1967, to a low of 2.6% in 1964. The frequency of calving difficulty differed with ages of dam, with two-year-old dams experiencing the most difficulty (29.7%). The three- and four-year-olds had somewhat more difficulty than the mature five through nine-year-olds, and the ten and older dams again had somewhat more difficulty. Calving difficulty was more pronounced in male births (10.5%) than in births of females (7.1%). There appears to be a large line of sire differences ranging from over 13% for the Brae Arden, Tarrington, and Controls, to less than 5% for the Animas, Bonanza, Don, Mesa, Rover and Model Domino lines of sire. This indicates a genetic influence on calving difficulty.

Using records from cows of all age classes, the heritability estimate of calving difficulty when considered as a characteristic of the calf was 7% and as a trait of the dam, 13%. Thus, the dam's

genotype (line of breeding) was more important than the calf's genotype in influencing calving difficulty. However, most calving difficulty occurs in two-year-old dams and analyses were conducted utilizing only calving records on two-year-old dams. As a characteristic of the calf, heritability was estimated at 13%, and as a characteristic of the dam, 0%, from calving records on two-year-old dams. In this case the genotype of the calf plays a much more important part in calving difficulty than the genotype of the dam. Apparently only certain lines of breeding dams continue to experience calving difficulty throughout their productive life, whereas all lines of breeding dams experience some difficulty as two-year-olds.

The repeatability of calving difficulty was estimated to be 4.5%. Of 195 two-year-old heifers which had no difficulty, 7.2% had difficulty as three-year-olds. Of 77 two-year-old heifers which all experienced calving difficulty, 11.7% had difficulty again as three-year-olds.

The association of calving difficulty with subsequent fertility is of greater importance than repeatability of calving difficulty. Among two-year-olds which had calving difficulty, 39.2% were open the following year whereas 25.3% of the heifers that had normal births were open. Thus, calving difficulty was associated with an additional 13.9% of three-year-old dams being open.

Calving difficulty also extended the calving interval which caused lighter weaning weights from heifers that did conceive after their first parturition. The calving interval between first and second calves from heifers which had a normal parturition was 345 days and the average weaning weight of second calves was 398 pounds. The calving interval between first and second calves from heifers experiencing calving difficulty was 357 days and their second calves averaged 366 pounds. Thus, heifers having calving difficulty had a 13-day longer calving interval and their calves weighed 32 pounds less than calves from contemporary cows having no difficulty.

7. A study dealing with genetic and environmental factors affecting cow productivity was completed. Cow birth year, age of cow's dam, line of cow's sire, cow's weaning weight and the cow's inbreeding level significantly affect cow productivity. Weaning weight means by cow birth year and age of cow's dam were negatively correlated with MPPA means (-.29, -.18, respectively). When cow weaning weight means were high, the cow MPPA means tended to be low and conversely, when cow weaning weight means were low, the cow MPPA means tended to be high. This indicates that a high preweaning plane of nutrition which resulted in higher weaning weights of the heifers was associated with lower subsequent cow productivity. Weaning weight means by line of cow's sire were positively correlated (0.79) with MPPA means, which indicates that weaning weight and cow productivity can be improved simultaneously. The correlation of the cow's weaning weight and her MPPA value was 0.14,

which indicates that the relationship between the cow's weaning weight and her subsequent productivity is low. The effect of high levels of cow inbreeding was detrimental to her productivity. These results indicate that a high preweaning plane of nutrition has a detrimental effect upon cow productivity.

The relationship between genetic effects on growth and genetic effects on maternal ability was estimated from parent-progeny groups. The most reliable estimates of heritability of growth potential, maternal ability and combined effects on weaning weights were 0.23-0.27, 0.34-0.40 and 0.28-0.34 respectively. The estimate of the genetic correlation between growth potential and maternal ability was -.28. Maternal ability of the cow accounted for slightly more of the variation in weaning weight than the growth potential of the calf. Estimates of the repeatability of weaning weight were 0.33 and 0.40 for linecross and inbred cows respectively. The conclusions from these analyses are that the total genetic effects on weaning weight are moderately heritable and that a weak genetic antagonism between growth potential and maternal ability exists.

The relationships of weaning weight, postweaning average daily gain, feed efficiency and grade of a sire's sons with the MPPA values of a sire's daughters also provided estimates of the genetic correlation between potential and maternal ability. The genetic correlations of MPPA with average daily gain, feed efficiency, grade and weaning weight were -.22, -.23, -.17 and 0.49. These results indicate a weak genetic antagonism between MPPA and average daily gain and grade, a weak positive association between MPPA and weaning weight.

The results of these studies of beef cow productivity in the experiment station herd indicate that a high preweaning plane of nutrition has a detrimental effect upon subsequent cow productivity. The estimates of the genetic relationship between growth potential and maternal ability indicate a weak genetic antagonism which does not appear large enough to seriously affect progress in selecting for heavier weaning weights in beef cattle. Heifers saved for replacements should be growthy heifers from productive dams. Creep feeding of heifer calves from which replacements will be selected should be avoided.

V. <u>Major Publications</u>: (1969-1970)

Brinks, J. S. 1970. 21st Annual Beef Cattle Improvement Day and Auction, Colorado General Series 906, May 9, 1970.

Hohenboken, W. D. and J. S. Brinks. 1969. Effect of environmental corrections on repeatability of weaning weight in Angus. J. Animal Sci. 29(4):534-540.

Hohenboken, W. D. and J. S. Brinks. 1970. Relationships between direct and maternal effects on growth in Herefords. II. Partitioning of covariance between relatives. J. Anim. Sci. 32(1):26-34.

Hohenboken, W. D. and J. S. Brinks. 1970. Relationships between direct and maternal effects on growth in Herefords. III. Covariance of paternal half brother and sister performances. J. Animal Sci. 32(1):35-42.

Mangus, W. L. and J. S. Brinks. 1970. Relationships between direct and maternal effects on growth in Herefords. I. Environmental factors during preweaning growth. J. Animal Sci. 32(1):17-25.

VI. Application of Results:

Selection for growth rate and carcass desirability should be effective since heritability estimates are relatively high and genetic correlations do not indicate antagonisms between important traits. Selection for daily gain will also improve carcass merit.

Linecrossing within a breed combined with performance testing and selection is an effective breeding program for producing superior cattle in rate of gain and carcass cutability.

Average weaning weights and lifetime production of cows can be increased by breeding heifers so they will calve early in the optimum season their first time.

Replacement heifers should not have an extremely high preweaning plane of nutrition since it could have a detrimental effect on future production.

UNIVERSITY OF HAWAII

I. Station: Hawaii Agricultural Experiment Station

II. Project title: The estimation of genetic and phenotypic parameters in populations of beef cattle in Hawaii and their uses in selection programs (201).

III. Personnel:

Experiment Station:
Diedrich Reimer, Project Leader, Oliver Wayman, C. M. Campbell and Dale Vogt.

Kahua Ranch Company, Ltd.:
Monty Richards, Jr.

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado:
Bradford W. Knapp, Acting Investigations Leader

IV. Major Accomplishments:

Records of progeny testing under two feeding regimes (feedlot vs pasture) for the period 1959-64 were analyzed by the method of least squares to determine the effects of years, sires, carcass weight and ration on carcass quality and eating quality. Traits studied included carcass grade, marbling, specific gravity, percent moisture, protein and ether extract in ribeye muscle, tenderness, juiciness, flavor, general acceptability, chew count, shear force, drip loss, evaporation loss and total cooking loss. Rations had a large significant effect on all traits except percent protein, juiciness and evaporation loss during cooking. Meat from feedlot steers was more tender and flavorful. Year differences were significant for all traits except percent protein and total cooking loss. Differences among sires were highly significant for specific gravity and significant for carcass grade, percent ether extract and percent drip loss during cooking. Differences among sires for all other traits were nonsignificant.

Heritability estimates and genetic, phenotypic and environmental correlations were computed from records on 357 bulls and 399 heifers. Traits studied were weights at 12 and 20 months, average daily gain from birth to 12 and 20 months and from weaning to 20 months, and conformation score at 12 and at 20 months of age. Constants for the effect of sire, age of dam and year were fitted for each sex separately.

Differences between sires were highly significant for 12-month weight and for average daily gain from birth to 12 months, birth to 20 months and weaning to 20 months for bulls and for 12-month weight and average daily gain from birth to 12 months and from birth to 20 months for heifers. Differences between sires were significant for 20 month score for bulls and heifers and for average daily gain from weaning to 20 months for heifers. Differences between sires for other traits were not statistically significant for either bulls or heifers. Differences between years were highly significant for all traits of both sexes.

Age of dam had no significant effect on any of the traits of bulls but had significant effects on all traits of heifers except average gain from weaning to 20 months of age.

Age of calf had a significant effect on 12-month weight and 12-month score of bulls and heifers, and on 20-month weight and 20-month score of heifers. Significant curvilinear regressions on age of calf were found for 12-month and 20-month conformation score of heifers.

Heritability estimates for bulls and heifers, respectively, were 0.76 and 0.26 for 12-month weight, 0.77 and 0.29 for rate of gain from birth to 12 months, 0.09 and 0.04 for 12-month score, 0.79 and 0.43 for 20-month weight, 0.78 and 0.44 for rate of gain from birth to 20 months, 0.27 and 0.09 for 20-month score and 0.54 and 0.10 for rate of gain from weaning to 20 months.

Genetic correlations among traits of bulls and heifers were high except the correlations of weight and rate of gain at 12 months with 12-month conformation scores of bulls and with 20-month conformation score of heifers. The environmental and phenotypic correlations were generally high except the correlations of rate of gain from weaning to 20 months with 12-month traits.

Studies were initiated in 1965 and in 1966 at two local ranches in cooperation with the University of Arizona and the U.S.D.A. Agricultural Research Service to evaluate the importance of genotype x environment interactions in beef cattle breeding. Frozen semen was used to breed cows by artificial insemination to bulls from the Regional Project. Conception rates have generally been low under the A. I. breeding program.

Data were collected to measure heterotic effects resulting from crossing the Angus, Hereford and Charolais breeds. A total of 590 calves were born over a 5-year period from 1966 - 1970. Number of cows exposed, number of calves born alive and calving percentages, respectively, for the various breeding groups were as follows: Angus, 105, 88, 84%; Hereford, 108, 96, 89%; Angus-Hereford reciprocal crosses, 175, 158, 90%; Charolais x Hereford, 93, 78, 84%; Charolais x Angus, 82, 69, 84%; 3-breed crosses, 60, 47, 78%; back-crosses, 25, 22, 88%. Similar data for all breeding groups combined were 648, 558, 86%.

Conception rate and percent calves weaned was higher in cows bred to produce cross-bred calves. No differences were observed in death loss at calving and in conformation score between crossbreds and straightbreds. Birth weights were heavier for crossbred calves, 12.5% for males and 10.3% for females. Heterosis was significantly higher in male calves than in females for preweaning daily gain (12.3% vs 3.3%, respectively) and for weaning weight (12.7% vs. 3.9%, respectively). Crossbred steers averaged higher daily gains in postweaning feedlot trials. Slaughter and carcass data indicate that crossbred steers had a slight advantage in ribeye area and percent retail cuts and only small differences existed in carcass grade and marbling score. Fat thickness was significantly less for Charolais-sired steers and highest for the straightbreds.

V. Major Publications: (1969-1970)

Reimer, D. and E. H. Cobb. 1969. Heterosis in preweaning and weaning traits among crosses of the Hereford, Angus and Charolais breeds. Haw. Agr. Expt. Sta. Tech. Bul. 83. (in press).

VI. Application of Results:

Results to date indicate that significant heterosis exists for preweaning and postweaning traits among crosses of the Angus, Hereford and Charolais breeds of beef cattle. These traits include birth weight, preweaning growth rate, weaning weight, postweaning daily gains and 20-month weights. Reproductive performance has been superior in cows bred to produce crossbred calves as compared to those bred for straightbred calves. Calving difficulties and death losses at birth do not appear to be adversely affected by crossbreeding. Conformation score at weaning has not shown significant response to method of breeding.

Interest in record of performance and the benefits to be obtained thereby have increased. The data accumulating from carcass evaluation of sire groups under two feeding regimes are providing a base for more efficient selection of replacement animals and for more realistic USDA beef grades. A Hawaii Beef Cattle Improvement Program was set up on the basis of research results from this project.

Some of the problems associated with artificial insemination of beef cattle have been identified. Heat detection, plane of nutrition and postpartum management of the cow herd have been found to be areas of critical importance for improving conception rates in an A.I. program under Hawaiian range conditions.

UNIVERSITY OF IDAHO

I. Station: Idaho Agricultural Experiment Station

II. Project title: The improvement of economically important traits in beef cattle with special emphasis on fertility and carcass quality.

III. Personnel:

Experiment Station:
R. E. Christian, Project Leader, T. D. Bell, M. L. Hemstrom, C. W. Hodgson and S. E. Slyter

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado:
Bradford W. Knapp, Acting Investigations Leader

IV. Major Accomplishments:

It is possible to determine age at puberty in the beef bull using the electroejaculator.

Hereford bulls produced satisfactory semen at 340.8 days of age, Shorthorn bulls at 330.7 days of age and Angus bulls at 374.4 days of age.

It was possible to produce erection of the penis approximately 90 days prior to successful ejaculation using the electroejaculator. However, the correlation between age at first erection and age at first successful ejaculation was too low for age at first erection to be used to predict age at first ejaculation (r = .141).

When steer calves from several farms were fed together in the feedlot, farm differences accounted for approximately one-third of the differences among the calves when first placed on feed. After a feeding period of 1[illegible] days, farm differences tended to disappear since they accounted for only 10 percent of the differences among animals at the end of the feeding period. This would indicate that progeny testing of bulls from different herds would be valid if their offspring are maintained together during the entire feeding period.

Significant year differences were found among progeny groups from the same sire. If the progeny test of sires is extended over more than one year, more than 10 offspring per sire are needed to detect sire differences.

V. Major Publications: (1969-1970)

None.

VI. Application of Results:

The cattlemen of Idaho have established a Beef Cattle Improvement Association to improve the performance and quality of the beef cattle in Idaho. They have relied heavily on the results obtained in this project. A bull progeny test station has been established to complement the production testing program.

MONTANA STATE UNIVERSITY

I. Station: Montana Agricultural Experiment Station

II. Project title: Recurrent selection and record of performance in open and closed beef cattle herds.

III. Personnel:

Experiment Station:
R. L. Blackwell, Project Leader, F. S. Willson, A. E. Flower, J. J. Urick, J. R. Dynes, Claude Windecker, R. W. Miller, D. C. Anderson

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado:
Bradford W. Knapp, Acting Investigations Leader

IV. Major Accomplishments:

Demonstrated that crosses of lines of beef cattle that have been on record of performance selection procedures for several years were superior for feedlot performance as measured by gains and final weights in the feedlots. This was accomplished both by comparing top cross progeny from R.O.P. selected bulls and those selected by conventional procedures at that time, and by comparing samples of cattle from industry with experiment station cattle.

Obtained large positive estimates of genetic correlations between gains of steers during three successive periods of growth and fattening (1st winter following weaning, the following summer, and the 2nd winter). Heritability estimates (paternal half-sib) for gain were 0.34, 0.43 and 0.00 for the three periods, respectively. Another study indicated that heritability (estimated by sire-offspring correlation) of birth weight and final feedlot weight were relatively high (50%), heritability of weaning weight and gain from birth to weaning were near zero and heritability of daily gain in the feedlot immediately following weaning was 34% in this group of cattle.

Correlations between weaning weight of the sire and various slaughter traits of steer progeny, slaughter weight, length of body and rib-eye area were positive and of the order of 0.3 to 0.4 when the steers were fed for a time constant period. Comparable correlations obtained from a separate body of data were lower when steers were fed out on a weight constant basis. Similar results were found for the relationship between feedlot gain of the sire and these carcass traits of steer progeny.

Age-of-dam effect on post-weaning gains of calves indicate a compensation in growth occurs due to the maternal environment associated with age of cow. Effect of inbreeding of the dam on weaning weight of bull and heifer calves appeared to be different. A relatively large negative regression for bulls (-1.71 lb. per 1% inbreeding of the dam) and a small negative regression for heifers (-0.14 lb. per 1% inbreeding of the dam) was found. Inbreeding of the calf had a small negative effect on weaning weight of both bulls (-.20) and heifers (-.11). Average inbreeding coefficients within three small closed lines (2 sire with 30-40 cows) increased only about one percent per year.

Heritability of 18-month weight of heifers was estimated to be 0.36. Correlations between 18-month weight of heifers and the corrected birth and weaning weights of their first calf were 0.27 and 0.24, respectively. Evidence of a sex-year interaction for weaning weight was found.

Studies of time trends in levels of production in small closed lines of cattle indicate genetic improvement for weaning weight resulted from selection. Evidently progress made was due primarily to mass selection practiced. Substantial selection differentials were obtained for daily gain and final weight, small positive selection differentials for weaning weight and negligible recurrent selection intensities for daily gain and final weight.

Performance of cross line progeny relative to inbred (mildly) contemporaries was generally superior for weaning weight and post-weaning gain. A hybrid advantage of 4.1, 4.3 and 4.7 percent was found for weaning weight, post-weaning daily gain and final weight, respectively. No evidence for hybrid advantage was found for birth weight. Calving dates of first calf heifers were found to be dependable in predicting subsequent mean lifetime calving dates of cows.

V. Major Publications: (1969-1970)

None.

VI. Application of Results:

Information and selection procedures resulting from the Montana project, along with that from other states, has been accepted by many in the beef cattle industry as being essential to efficient production. Interest created by the research program that was conducted with practical application of results as an underlying principle, and the support of extension livestock specialists, resulted in the organization of the Montana Beef Performance Association. This is an industry-supported organization that provides

recording and other services to cattle breeders in the utilization of records of performance in selection. This organization has been effective in obtaining more widespread acceptance of these principles and procedures which have been shown by research to be sound both biologically and economically. As a result, those who conscientiously employ record-of-performance procedures in their cattle breeding efforts are reaping substantial benefits. Agricultural lending agencies, such as commercial banks, are emphasizing the use of these R.O.P. procedures to their clients who are beef cattle producers. Feedlot operators recognize the value of cattle with genuine R.O.P. backgrounds.

I. Station: Montana Agricultural Experiment Station

II. Project title: The genetics of certain protein components in milk from beef cows.

III. Personnel:

Experiment Station:
A. M. El-Negoumy, Project Leader, A. E. Flower, A. B. Weston, R. L. Blackwell, O. F. Pahnish

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado:
Bradford W. Knapp, Acting Investigations Leader

IV. Major Accomplishments:

Milk samples from beef cows (inbred and line cross Herefords, and purebred Hereford, Angus, Charolais, and various crosses among the Hereford, Angus, Charolais and Brown Swiss) have been typed for various protein components. Typing by starch gel electrophorisis was accomplished on some 500 samples. Genetic analysis is now progressing. Preliminary analysis of limited data indicate different frequencies of Kappa A and Kappa B in two groups of Hereford, but not in other protein components (Alpha and Beta groups). Differences in the frequency of occurrence of certain protein components suggests breed differences are present. Research will continue to obtain frequency estimates of genes that control the various protein fractions and to obtain the degree of association between production characters and the protein fractions.

V. Major Publications: (1969-1970)

None.

VI. Application of Results:

No results are presently available that can be applied to the improvement of beef cattle.

UNITED STATES RANGE LIVESTOCK EXPERIMENT STATION

I. Station: U. S. Range Livestock Experiment Station, Miles City, Montana.

II. Project titles: 1. Development and testing of methods of measuring performance in beef cattle. 2. Development of superior lines of beef cattle. 3. Breeding crossing for increased production in beef cattle. 4. A study of response to selection and genetic-environmental interaction in genetically similar groups of Hereford cattle at two locations.

III. Personnel:

U. S. Range Livestock Experiment Station, Miles City, Montana:
O. F. Pahnish, R. A. Bellows, C. G. Hankins, N. M. Kieffer, B. Knapp, Jr., J. R. Quesenberry, F. J. Rice, J. J. Urick, and R. R. Woodward

Montana Agricultural Experiment Station, Bozeman, Montana:
D. C. Anderson, R. L. Blackwell, A. E. Flower, R. B. Gibson, T. M. Riley, and F. S. Willson

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado:
J. S. Brinks, R. T. Clark, B. W. Knapp, and C. E. Shelby

Cooperators:

U. S. Department of Agriculture, Agricultural Research Service, Beltsville, Maryland:
E. J. Warwick, Assistant Director, Animal Science Research Division

P. A. Putnam, Chief of Beef Cattle Research Branch

R. L. Hiner, Meat Quality Investigations Leader

W. T. Butts, Jr., Investigations Leader (Southern Region), Knoxville, Tennessee

W. C. Burns, Superintendent, West Central Florida Experiment Station, Brooksville, Florida

Florida Agricultural Experiment Station, Gainesville
Marvin Koger, *et al.*

IV. Major Accomplishments:

Early studies at the U. S. Range Livestock Experiment Station, Miles City, prior to the activating of the W-1 projects, contributed important information on procedures for testing and recording performance in beef cattle. Because these procedures contributed importantly to the W-1 projects, which followed in later years, they are discussed briefly.

From these earlier testing procedures developed it was shown that there were inherited differences between progeny of various sires for such important traits as weaning weights, daily gain and efficiency of gain in the feedlot, dressing percent, weights of heifers at 18 and 30 months of age. It was, therefore, recommended that selection procedures in range cattle should be based on these traits.

Studies with cows and calves on the range showed that cows almost reached maximum weight at 5 years, but gained only a slight amount after 3 1/2 years. Maximum birth weights were obtained from 4-year-old cows. Heaviest calves at weaning were from 6-year-old cows with a range of 5 to 8 years being the best producing years. Because cow production dropped noticeably past 9 years of age, it was recommended to cull all older cows to maintain maximum production. Cow size seemed to be more important for increasing calf birth weight than did sex or sire.

Incidence of bloat in steer progeny groups was found to differ by lines and sires, thus indicating that there are inherent differences between sires for producing feedlot bloat. Thus, selecting of sires with minimum of bloating problems under conditions of heavy feed consumption was recommended to reduce feedlot bloat.

Comparisons were made in steer progeny groups to determine the relationship between rate of gain and efficiency. In this study, when corrections were made for differences due to size, the correlation between daily gain and corrected efficiency was found to be 0.83. Thus, it was suggested that daily gain could be used quite accurately to predict efficiency of gain at comparable weights. This information was partly responsible for another selection procedure (bull indexing) that put into practice testing weaned bull calves for gainability and efficiency of gain to determine those superior for replacement sires.

Some of the first heritability estimates obtained at this Station from steer progeny groups and reported in 1946 ranged from zero to 0.99. While these first estimates, for postweaning weight and gain were considered to be higher than seemed reasonable, they nevertheless were considered meaningful enough so that beef breeders and feeders were encouraged to select for greater gain and efficiency of feed utilization. These first results showed birth and weaning

weights, respectively, to have a fairly low heritability and they were therefore not recommended as important traits in selection procedures to increase production.

In another study, reported in 1947, with steers during a 252-day postgain feed period, it was found that the environmental influences seemed to control gains more importantly during the first 84-day period than did the genetic influences, conversely, during the third 84-day period the opposite was true. Overall period results indicated that when environmental influences were reduced as much as possible, that heredity played an important part in determining the calf gains in the feedlot. From this information it was recommended that the feeding period be a minimum of 140 days to measure inherent differences.

With addition of steer progeny data, revised heritability estimates were obtained and reported in 1950. These estimates, though somewhat lower than previously reported, still indicated a fairly high hereditary influence on growth after weaning. Quality and conformation were not shown to be influenced to an important extent by heredity.

From the above discussion it is apparent that a considerable amount of knowledge for the improvement of cattle breeding and management was gained in the earlier period of performance testing beef cattle at the Miles City Station. This information provided important guidelines for making recommendations for selecting and management of beef cattle in the industry herds as well as improving the selection procedures in the Station herd. In 1947 the initial W-1 contributing project was initiated and was titled, "Identification and Propagation of Genetically Superior Lines of Beef Cattle and Testing Breeding Values of Hereford Cattle". The main objectives were: (1) to improve beef cattle production with respect to quality and efficiency through the use of sib tests and progeny tests for predicting value of lines and combinations of lines of beef cattle and through propagation and distribution of superior lines and combinations; (2) to establish lines of beef cattle particularly adapted to range conditions with: (a) high fertility, (b) capacity to make gains rapidly and economically, (c) high dressing percentage of edible beef of superior quality and (d) desirable body conformation.

The regular research program was to continue, as in the past, to investigate basic research problems, to furnish information on how to develop better lines and how to utilize genetic variability. The new program was to utilize accumulated information to test, synthesize and put to use in the field, new lines of superior beef cattle.

In the initial stages of the line development program, starting after 1947, there were 11 lines included. Three of these (lines 1, 2 and 3) were formed in the period 1934-1940 and used extensively in record of performance studies. Seven new lines (Lines 4, 5, 6, 7, 8, 9 and 10) were acquired from various sources after 1947. One line (Line 11) was formed from crossing Lines 1 and 5.

The selection procedures used to develop and improve the performance in these lines was determined to a large extent by the magnitude of the heritability of traits considered economically important for beef cattle as discussed previously.

By 1952 revised estimates of heritability were determined and were:

Trait	Percent	Trait	Percent
Birth weight	53	Weaning score	23
Weaning weight	28	Slaughter steer grade	45
Weight at 15 mo.	86	Carcass grade	33
Rate of gain	65	Area of eye muscle	68

As can be observed from the above values, two traits that were found to be highly heritable and considered quite important economically were rate of gain and weight at 15 months. In the line development program, considerable selection pressure was, therefore, placed on these two traits. A small amount of direct selection was placed on weaning weight and practically none on birth weight.

Although the few carcass traits studied showed a reasonably high heritability, probably only a small amount of direct attention was given to them in the selection program for two reasons: (1) in some cases sires were selected and used at yearling age and before any carcass information was obtained on the progeny; (2) where carcass information was obtained on progeny, this generally was at a period after sires were placed in the breeding herd.

The resulting carcass information obtained in steer progeny from sires in the various lines, however, has produced some interesting research information for relating various carcass traits to live animal body characteristics. Some of these first comparisons are shown in table 1.

From this study (table 1) the growth measures tended to be positively correlated in most instances with the carcass traits studied. Weaning weight was negatively correlated with efficiency of gain but had a significant positive correlation with thickness of fat over the ribeye. Efficiency of gain was not significantly correlated with any of the measures of carcass quality. There was some evidence of a negative relationship between rate of gain and fat thickness on a constant final weight basis. Area of eye muscle was not correlated with gain on test when final weight was held constant.

Table 1. Correlations of weaning weight, gain on test, and final weight with other traits within lines and years.

	Simple correlations 1/			Partial correlations	
Trait	Weaning weight	Gain on test	Final weight	Weaning 2/ weight	Gain 3/ on test
Efficiency	-.29*	0.47*	0.09	0.40*	
Slaughter grade	.17*	.49*	.51*		
Carcass grade	.16*	.43*	.40*	.01	
Area of eye muscle	.32*	.36*	.44*	.20*	0.00
Thickness of fat	.21*	.07	.33*	.25*	-.21*
Dressing percentage	--	-.01	.25*		
Length of body	--	.14*	.78*		-.03
Length of leg	--	.56*	.70*		-.09
Final weight	.63*	--	--		
Gain on test	.23*	--	--		

1/Asterisk indicates significant correlation at 1-percent level.
2/Computed with gain held constant.
3/Computed with final weight held constant.

Slaughter grades tended to predict fat thickness but not area of eye muscle. Thus, it was suggested that too much emphasis was placed on external fat in grading steers and not enough on area of eye muscle in determining the carcass grade. In this experiment long-bodied steers appeared to have carcasses as desirable as those of the short-bodied steers.

The use of ultrasonics and photogrammetry at this Station in fairly small numbers of steers have shown some promise for predicting certain desirable carcass characteristics. In a group of 38 steers, photogrammetry was used to obtain linear measurements which were used to predict wholesale cuts of beef. When animals were adjusted to 1000 pounds of live weight the study indicated that there was a high accuracy in predicting percent wholesale cuts.

The first ultrasonic measurements were taken in 1961 on 52 steers. Results of this study showed a small but positive correlation (0.15) between the ultrasonic fat thickness and carcass fat depth. These results were not too encouraging for recommending ultrasonic procedures for predicting fat thickness in breeding stock.

A study was initiated in 1960 to develop one line of grade Hereford cattle for high carcass quality. Two selection criteria were used. These were low fat thickness as estimated from ultrasonics and high final weight. To date the most noticeable improvement in this line is some increase in final live weight and carcass weight. No definite trends of a changing fat desposition are evident to date.

Revised estimates of heritability reported in 1955 showed some changes from earlier reports but in general were in close agreement and were as follows: birth weight 0.72, weaning weight 0.23, gain in the feedlot 0.90, final weight at end of feedlot 0.84, efficiency of feed use 0.22, slaughter grade 0.42, shrink 0.91, dressing percentage 0.73, carcass grade 0.16, color of eye 0.31, area of eye muscle 0.72, and thickness of fat 0.36. In this group of 635 Hereford steers (representing 68 sires and 9 inbred lines) it was reported that there were significant differences in feed utilization between lines within years. When comparing sires within lines, there were not significant differences for carcass grade, but there were significant differences for weaning weights, and highly significant differences for other growth traits. From these data it was proposed that selection for growth traits be based on the individuals own record, but selection for carcass traits be based on sib or progeny test. This study, thus, was partly responsible for procedures adopted in the initial stages of bull indexing in the feedlot.

A comprehensive study reported in 1955, based on data of 5,952 Hereford calves raised from 1926 to 1951 at the Miles City Station, resulted in some useful adjustment factors, particularly for correcting differences due to age of dam and sex. Those obtained for ages of dam are shown in table 2.

Table 2. Correction factors for age of cow.

Age of cow	Birth weight	Weaning weight	Weaning score1/	Fall yearling weight	Fall yearling score1/
yrs.	lb.	lb.	units	lb.	units
3	4	41	.6	24	.1
4	2	18	.3	13	[illegible]
5	0	6	.2	3	0
6	0	0	.0	0	0
7	0	3	.0	2	.1
8	0	6	.1	4	.1
9	0	12	.2	7	0
10	2	24	.4	14	0

1/ In scoring system used, the difference between grades is 1.5 units.

The correction factors (table 2), used extensively in later studies in this herd to make the necessary adjustments in calf weights, were also used widely throughout the industry. In this group of calves, males (bulls and steers averaged together) were 5.6 and 26.2 lb. heavier than heifers, respectively, at birth and weaning.

The influences due to environment have been fairly large over a period of years at this Station. These environmental factors must be considered in comparing records made within the same herd in different years. Results from this Station suggest that records of animals born in the same herd in different years can be compared when expressed as percentages of yearly herd averages. Before making these comparisons, records must be adjusted to a uniform age, age of dam and sex basis.

A study on mature weights in Hereford cows was reported in 1962. In this study, mature weights for various ages of cows were as shown in table 3.

In the above study it was reported that heritabilities of average spring and fall weights of cows were estimated at 0.75 and 0.73, and based on single records were estimated at 0.57 and 0.62. The correlations between cow and calf weights were small but indicated that heavier cows tended to produce heavier and faster gaining calves. In the same herd a later study showed that the best prediction of a cow's real producing ability was her own 18-month weight in comparison to other growth traits from birth to maturity. A negative correlation between mature fall weight and real producing ability suggested that the cows producing the heaviest calves at weaning lose the most weight.

Table 3. Least squares means and constants for cow weight by age classes.

Age		Spring weight		Fall weight	
class	Number	Mean	Constant	Mean	Constant
3	2027	990	-129	1014	-100
4	1817	1053	- 66	1073	- 41
5	1447	1112	- 7	1116	2
6	1169	1143	24	1134	20
7	939	1160	41	1141	27
8	751	1165	46	1152	38
9	559	1165	46	1143	29
10+	536	1161	42	1139	25
$\hat{\mu}$	9245	1119	..	1114	..

From a study including 2,151 heifer and 2,281 steer calves dropped from 1931 through 1953, and 330 heifer and 345 bull calves produced in the purebred herds in 1958 and 1959, some further sex adjustment factors were obtained for growth traits to weaning. These data indicated that the multiplicative adjustment factor (ratio of the means) is more satisfactory than an additive type adjustment for birth weight, gain to weaning, and weaning weight. To adjust to a heifer basis, the adjustment values used were: birth weight, 0.934 X males; pounds of gain from birth to weaning, 0.942 X bulls and 0.952 X steers; weaning weight at 180 days, 0.949 X steers and 0.941 X bulls. From comparisons made in the test herd there was a highly significant advantage of 20.9 pounds for steers over heifers. In the purebred herd, bulls had a highly significant advantage of 24.1 pounds over heifers.

The sex ratios occurring in this herd were reported in 1963. This summary is shown in table 4.

Table 4. Sex ratios from birth to weaning.

Sex	All calves born		Born dead		Died birth to weaning		Calves alive at weaning	
	No.	%	No.	%	No.	%	No.	%
Male	5953	51.5	247	57.8	150	47.9	5553	51.3
Female	5605	48.5	180	42.2	163	52.1	5271	48.7

Males tended to have a greater death loss at birth while heifers showed a slight more death losses from birth to weaning; the net result was that the sex ratio stayed nearly the same at weaning as it was at birth as shown in table 4.

Several studies contributing important information relating to physical unsoundness in the herd were reported as the result of the W-1 contributing projects. The first of these was the study on cancer eye incidences reported in 1958. In this herd of Herefords incidences of cancer eye in Lines 1, 2 and 3 were studied and amounted to 4.7, 10.2 and 4.8 percent, respectively. The average incidence of cancer eye was found to be 4.7 percent in the entire herd and was found to increase at 5 and again at 7 years of age. In comparing incidences of cancer eye in mother and daughter pairs and in progeny of several sires it was concluded that susceptibility to cancer eye appeared to be hereditary.

In 1957, a summary of incidences of vaginal and uterine prolapse was reported. From 7,059 parturitions occurring in range cows at the Miles City Station from 1935-1954 the year-to-year incidence of prolapse ranged from 0.0 to 2.7 percent. Incidences

of prolapse at the Havre, Montana, Station from similar lines of cattle that were on a higher plane of nutrition at calving appeared somewhat less than was experienced at the Miles City Station. There was not a significant age-of-cow effect on incidence of prolapse. First-calf heifers and cows over 7 years had the highest percent of prolapse. Significant line differences for prolapse suggested that this characteristic was heritable. It was recommended that herds be culled rigorously to control this weakness.

A 1959 study of 8,857 births from 193[illegible]-1957 showed that 3.6 percent of the calves were stillborn. Factors associated with stillbirths occurring at that time are shown in table 5.

Table 5. Identified factors associated with stillbirths (193[illegible]-57).

Factors	Number of stillbirths	Percentage of total
Dystocia	50	37.0
Posterior presentation	35	25.9
Malposture of fetus	9	6.7
Twinning	11	8.1
Abnormal fetus	30	22.2

From this study it was found that there was a significantly higher number of males stillborn than females. A significantly higher number of calves were stillborn in the inbred herd than in the non-inbred grade herd. Calves lost from dystocia had a greater range in birth weights and averaged 10 pounds lighter than those born alive. First-calf heifers (3 years of age) had 6.7 percent stillbirths as compared to 2.4 for all other females. A lack of descriptive detail hampers identification of some apparent lethals that were observed.

In a later period, from 195[illegible]-1961, calving losses in straight Hereford matings amounted to 4.7 percent from a total of 3,049 parturitions. In this study 21 percent of the autopsies revealed various skeletal or organ abnormalities.

Fertility information in range cattle reported in 1961 indicated that fertility in the first-calf heifers was a fairly good prediction of their future productivity in the herd. In this study, 7,[illegible] cow-year records on 1,589 cows in the herd from the period 1928 to 1951 were used. The average calf crop for this period was 82.6

percent. Heifers that were dry the first year had a 54.9 percent lifetime calf crop as compared to 86.8 percent for those having a calf the first year. From these results ranchers were urged to cull first-calf heifers for shy breeding to increase percentage of calf crop. In this study calving percentages were not affected significantly by age of dam and inbreeding.

Although an overall evaluation of performance of all lines was not completed until the early 1960's, one study reported in 1951 was the first to show in some detail what was happening in the development of one line (Line 1) over a period from 1934 through 1948 with rather close breeding. In this line the original mating scheme was to make half-brother-sister matings as far as possible. From 1934 to 1948, inbreeding of calves reached an average of 16 percent. During this period, with rather intense selection for gainability, results showed that the line increased in rate of gain and weight for age with no loss of carcass quality. Estimates of heritability as obtained from this line were higher than those obtained from the entire Station herd. Progress made in this line was encouraging enough so that the industry was urged to follow similar procedures for developing lines in which selection is based on economic importance.

In this same line, a later study of the response to selection was made from a total of 2,027 calves sired by 33 bulls from 1934 to 1959. In this period inbreeding increased from an average of 0.7 to 21.6 percent. Inbreeding affected weight most at 18 months in the females. In the bulls, weight at 12-13 months was affected more by increased inbreeding than were earlier weights. Inbreeding in the dam decreased gain from birth to weaning, and weaning weight of calves but this loss was gained back at 18 months by the heifers and almost regained by the bulls at 12-13 months.

Inbreeding of calf affected heifer calves more than bull calves, but inbreeding in the dam affected preweaning performance of bulls more than heifers. The proposed explanation for the latter observation was that inbreeding of dam reduced milk production and that this, in turn, suppressed potential growth in bulls more than in heifers.

In the study just described, environmental, phenotypic and genetic trends were computed to estimate genetic progress in the line from 1934 to 1959. Estimates of progress were as follows: birth weight, 9.7 lb.; gain from birth to weaning, 21 lb.; weaning weight, 30 lb.; weaning score, 1.5 percent. In view of the intensity of selection practiced, estimates of genetic progress were slightly larger than expected even though no adjustments for effects of inbreeding were made. There was a greater amount of selection pressure practiced on the side as the selected bulls represented the top 18 percent of the population. This comprares to the top 89 percent of the population that the selected heifers represented.

Data from 542 bull calves on R.O.P. test from 1940-1954 were analyzed for further evaluation of the inbred line and to obtain estimates of heritability. Lines in the herd during this period differed importantly in weaning weight, gain in the feedlot, efficiency of feed utilization, and final weight. These results indicated that the 13 months weight was the most valuable criterion for selection. Heritability estimates from this bull data was as follows: gain in the feedlot, 0.46; final weight (13 months), 0.77; adjusted final weight, 0.55; and efficiency of feed utilization, 0.32.

A group of [illegible] steers from 11 lines and by 87 sires were used, in 1963, to study correlated responses from single trait selection. The correlated response between final feedlot weight and other growth traits in the bulls was high enough to indicate it would be an effective trait to use in mass selection. This was further substantiated in analyses of heifer data reported in 1964 in which selection for 18-month weight gave an 82 percent correlated response in weaning weight, and in 12-month weight the correlated response appeared to be equally as effective. In the bulls it was reported that little correlated response in desired carcass traits (excluding carcass weight) would result from selection for preslaughter traits except for length of body and leg.

A summary of all Miles City Station heritability estimates, by paternal half-sib correlation is presented and shown in table 8.

By 1961 a substantial amount of data was available on the performance of all 14 inbred lines of cattle established at this Station. Of these lines six were discarded after a period of testing, primarily for below average performance. Several of these lines had difficulty adjusting to full feeding conditions in the feedlot and showed fairly high incidences of bloat. Poor weaning weights and generally below average weights resulted in culling of several others. The relatively new lines (11, 12 and 14) formed by crossing inbred lines excelled in most growth traits. The more highly inbred lines (1, 4, 6, 9 and 10) differed widely in growth measurements at various stages of growth from birth to maturity.

The favorable performance of the newly formed lines (resulting from line crosses) were encouraging enough to initiate more line crossing to determine the importance of hybrid vigor from crossing inbred lines. To determine the importance of heterosis from crossing inbred lines, a linecrossing study was initiated in 1961 with Lines 1, 4, 6, 9 and 10. These were crossed in all combinations to produce all possible reciprocals during a 4-year period. Approximately 30 cows from each line were assigned to the study. Each year sires were changed and replacement females going into the line were those produced in that line.

Table 6. Miles City heritability estimates--paternal half-sib correlation.

	1948		1950	1951	1955		1957	1960	1963	1964[e]
Bir. wt.	0.23	....	0.53	....	0.72	0.35	0.50	....	0.54	0.38
Gn. bir. to wn.	....	....	....	....	....	0.21	0.40	....	....	0.40
Wn. wt.	0.12	....	0.28	....	0.23	0.24	0.43	....	0.24	0.43
Wn. sc.	....	0.53	0.28	0.31	....	0.18	0.60	....	0.23	0.28
Feedlot gn.	0.99	....	0.65	0.70	0.60	....	....	0.41	0.48[b]	....
Fin. wt.	0.81	....	0.86	....	0.34	....	....	0.77	0.64	....
Sl. wt.	....	....	....	....	....	....	....	....	0.70	....
Shr., lb.	....	....	....	....	0.91	....	....	....	0.50	....
Shr., %	....	....	....	....	....	....	....	....	0.53	....
180-day wt. ÷252-day gn.	....	....	....	....	....	....	....	0.55[a]	0.55	....
Sl. gr.	....	0.63	0.45	....	0.42	....	....	....	0.35	....
Carc. gr.	....	0.64	0.33	....	0.16	....	....	....	0.17	....
Feed effic.	0.75	....	....	....	0.22	....	....	0.32	....	....
Length body	....	....	....	....	....	....	....	....	0.46	....
	....	....	....	....	....	....	....	....	0.20[c]	....
Length leg	....	....	....	....	....	....	....	....	0.76	....
	....	....	....	....	....	....	....	....	0.41[c]	....
Dress. %	....	0.01	....	....	0.73	....	....	....	0.57	....
Cold carc. wt.	....	....	....	....	....	....	....	....	0.57	....
Area eye musc.	....	0.66	0.68	....	0.72	....	....	....	0.26	....
	....	....	....	....	....	....	....	....	0.46[c]	....
Thick. fat	....	....	....	....	0.38	....	....	....	0.24	....
over eye	....	....	....	....	....	....	....	....	0.22[d]	....
Col. eye musc.	....	....	....	....	0.31	....	....	....	0.49	....

[a] 180-day wt. ÷ 196-day gn.
[b] A.D.G.
[c] Adjusted for sl. wt. by linear and quadratic regression.
[d] Adjusted for sl. wt. by linear regression.
[e] These estimates are from Hereford heifers.

From this study a total of 241 bull and 228 heifer calves were produced. In this study heifer calves showed more heterosis than bull calves. The explanation for this was that the linecross bulls were probably set back more than heifers because of a limited milk supply from the inbred dams. Heterosis for birth weight, preweaning daily gain, weaning weight and weaning score amounted to 3.8, 10.6, 9.4, 2.7 percent for heifer calves and 3.0, 5.6, 5.1, and 2.5 percent for bull calves, respectively. Some lines exhibited greater maternal ability while others excelled in growth traits. One line, however, excelled in maternal ability and in most all growth traits.

In the postweaning phase of this linecrossing study, heifers continued to exhibit more heterosis than the bulls. Percent heterosis obtained for heifers was: 12-mo. weight, 9.4; 18-mo weight, [illegible]; gain from weaning to 12-mo., 9.5; gain from weaning to 18-mo., 3.7; gain from 12 to 18-mo., 1.1; and 18-mo. conformation score, 4.6. Percent heterosis obtained for bulls for weights taken every 28 days during a 196-day feed test period was: initial weight on feed, 6.7; period 1, 7.3; period 2, 6.4; period 3, 5.6; period 4, 5.3; period 5, 5.0; period 6, 4.9; and final weight, 4.5. Percent heterosis obtained for bull gains for each 28-day period and during the 196-day test was: period 1, 13.0; period 2, 1.4; period 3, 0.3; period 4, 2.5; period 5, 2.2; period 6, 4.9; period 7, -2.2; and 196-day gain, 2.9.

From these results it appeared that some of the advantage of crosslines over the straightlines in postweaning performance may have been due to a greater resistance to weaning stress. This was most evident during the warm-up period following weaning when the linecross bulls gained while the straightlines lost weight. During the first 28-day feed test period the linecross bulls continued with a significant advantage in gain over the straightlines. Thus, while the overall advantage of the linecross bulls over the straightlines for the entire 196-day period was 2.9 percent, period gains showed that a large portion of this advantage resulted early in the period following weaning.

The heterosis obtained in this linecross study exceeded that obtained in the concurrent corssbreeding study at this Station; this was most evident in the heifers. It is reasoned that the heterosis obtained in the linecrossing should be less than that from crossbreeding. A portion of the heterosis obtained in the linecrossing could be partly due to a recovery from inbreeding depression. Further estimates of the effect of inbreeding depression on these inbred lines are needed to arrive at a more precise evaluation of heterosis in the linecrossing study.

A phase 2 linecrossing study was initiated in 1964 and designed to compare some maternal qualities of linecross and straightline dams. Four calf crops were produced during the period from 1965 to 1968. Preliminary summaries of these data showed the bull and heifer calves from the linecross dams were 3.8 and 2.8 percent heavier at weaning, respectively, than from the straightline dams. During the postweaning feed test there appeared to be no advantage for either group of bulls for gain, but those from the linecross dams showed about a similar final weight advantage as at weaning. Thus, maternal influences in the linecross dams seemed to contribute to heavier weaning weights and final weight off test, but not for gain in the feedlot. These results have not been examined statistically yet to determine the degree of significance. Fertility in the linecross dams was somewhat higher than in the straightlines.

A phase 3 linecrossing study was initiated in 1967 to compare four mating systems (within line mating, two-way rotation, three-way rotation and synthetic variety) to obtain estimates of heterosis that might be obtained and maintained over a period of time. The preliminary results show some advantage in weaning weight for calves from the two- and three-way rotations and synthetic variety systems over the ones from the one-way scheme. At this stage weaning weights and postweaning weights and gains from the two- and three-way rotation schemes and synthetic variety are inconsistent. Data from several additional years are needed before the study can be expected to produce meaningful results during the preweaning and postweaning period.

A study to determine the effectiveness of selection procedures to improve performance was made possible through storage of semen of Line 1 and Line 10 sires from different generations. By breeding sires of each line from different generations concurrently to grade cows over a two-year period, it was possible to minimize the environmental influences and, thus, make it possible to make comparisons of breeding value of different generation sires. Two calf crops produced by artificial insemination and dropped in 1966 and 1967 were from Line 1 sires born 1953 to 1955 and 1961 to 1963. Two calf crops dropped in 1968 and 1969 were from Line 10 sires that were born 1951 to 1955 and 1963 to 1965. Preliminary summaries (statistical analysis has not been completed) show advantages in all growth traits for the progeny from the more recent sires in both lines. The preliminary results seem to be in fairly close agreement with those obtained when studying the response to selection in the Line 1 herd as discussed previously in this report. Thus, it seems that the selection procedures used in this herd should be expected to improve the performance of stock importantly for most growth traits. Breeders have been encouraged to follow similar selection procedures to increase production in beef herds.

A second phase of this selection study is to compare maternal qualities of heifers from the different generation sires. The maternal qualities exhibited by the heifers should contribute importantly for the further evaluation of selection procedures practiced in this herd. The final calf crop from the heifers should be obtained in the fall of 1973.

Results from a crossbreeding study (phase 1) involving Angus, Hereford and Charolais beef breeds were reported in 1969. Heterosis for birth weight, preweaning daily gain, weaning weight and weaning score amounted to 4.4, 3.7, 3.8 and 2.2 percent for steer calves and 1.4, 2.0, 1.9 and 0.4 percent for heifer calves, respectively. When Brown Swiss cows were crossed with Angus, Hereford and Charolais sires, they produced first-cross steers and heifer calves weighing, respectively, 11.9 and 14.0 lb. more at birth, and 74.1 and 71.7 lb. more at weaning than the beef X beef first-crosses from the same

sires and straight beef dams. All breed groups of calves were within the middle to high choice feeder group, with those from beef dams showing a slight advantage over those from Brown Swiss dams. Relatively low fertility of the Brown Swiss straightbred cows cancelled out any contribution of superior calf growth to pounds of calf weaned per cow exposed during the breeding season.

During the postweaning feedlot period, the heterosis exhibited in the crossbred steers for initial weight, daily gain on test and gain/cwt. T.D.N. amounted to 4.2, 3.7 and 3.3 percent, respectively. Heterosis obtained for slaughter and carcass grade was 2.[illegible] and 1.1 percent, respectively. The beef X Brown Swiss steers gained the same as the beef X beef steers but with slightly less efficiency. Although beef X Brown Swiss steers at slaughter graded 2/3 of a grade lower than the beef X beef steers, they graded almost the same in the carcasses that exhibited less outside fat.

The phase 1 crossbreeding study yielded further information on breed effects on puberty in both bulls and heifers. Crossbred bulls reached breeding age 42 days sooner than straightbreds and exhibited slightly more libido. Charolais bulls reached satisfactory breeding ability at a later age than the Angus or Herefords. Angus heifers reached puberty first and were followed by Charolais and Herefords in that order. Charolais heifers were the heaviest at puberty when compared to either Angus or Herefords. When all straightbreds were compared with all beef crossbreds, the study shows the crossbreds reached puberty 12 days sooner and were six pounds heavier. Beef X Brown Swiss heifers reached puberty 23 and 35 days sooner than beef crossbreds and beef straightbreds, respectively.

From the phase 1 crossbreeding study females produced were used to study some maternal qualities of crossbred and straightbred females. Preliminary comparisons in the phase 2 crossbreeding showed that crossbreeding in the dam accounted for 5.0 percent more calf weight at weaning per exposed cow. The beef X Brown Swiss females weaned 10.8 percent more calf weight per exposed cow than did the beef X beef crossbred females.

A current crossbreeding study (phase 3) was designed to estimate hybrid vigor that can be obtained and maintained through two-way and three-way rotational crossing of Angus, Charolais and Hereford breeds. In addition, a synthetic variety is being formed from the three breeds. The preliminary results show some advantages in preweaning and postweaning growth for the crossbred calves over the straightbreds. There are some inconsistencies in the performance of crossbred calves from two- and three-way rotation and synthetic variety; thus, the accumulation of more data will be needed in this study before the results can become meaningful.

As an adjunct to the beef crossing study (phase 3) some beef X Brown Swiss females were carried and bred to beef bulls. From preliminary data, results show that the beef X Brown Swiss females (first-crosses bred to a second beef breed) produced about 4.7 percent more calf weight at weaning per exposed cow than did the beef X beef females bred for backcross calves.

Comparisons of straightbred Angus, Charolais and Hereford cows from phase 1 producing straightbred and crossbred calves were made to determine some cow-calf weight relationships. In this study cow weights were used as a measure of size. The average weights of Angus, Hereford and Charolais cows were 1107, 1180 and 122[illegible] lb., respectively. Increases in cow weight resulted in small but positive increases in calf weight. The calf weight increase per unit of cow weight increase was not significantly different for the three breeds of cows. In this study the relationship of cow weight to the 0.73 power with calf weight was also computed. This cow-calf weight relationship differed little from the relationship involving actual cow weight. Comparisons of cow weights from the current cow population, show that crossbreeding, through hybrid vigor, increased cow weights about 22 pounds. Crossing Angus and Herefords with Charolais, however, resulted in an advantage of over 100 pounds for the crossbred cows over the straight Angus and Herefords. Crossbred cows with 50 percent Brown Swiss breeding were about equal in weight to the British X Charolais cows.

A genetic-environmental interaction project was activated in 1961 to see how cattle that are selected to perform well in a given locality or environment would perform in a different locality or environment. Two lines of Hereford cattle were used in this study. The Miles City Station cattle in this study were from a herd maintained as a closed line since 1934. Average inbreeding of these cattle was approximately 25 percent at the beginning of the study. The cattle from the West Central Florida Experiment Station, Brooksville, represented at least two generations of selection in the south. These cattle were somewhat more heterogeneous as to bloodlines than the Montana cattle and were not inbred. The cattle originating at Miles City and those from Brooksville were subdivided and half of each transferred to the other location. From the first seven years data (1962-1968), resulting location-origin interactions were apparent in birth, weaning and yearling weights ($P<.01$) for both sexes.

Performance to yearling ages favored cattle of Montana origin in Montana and cattle of Florida origin in Florida. Five-year-old cows of Montana origin were about 100 pounds heavier at both locations. When comparing reproduction of herds at different locations the females of Florida origin showed an advantage in percent of cows pregnant and net calf crop weaned at each location, but the advantage was greater in Florida than in Montana. Data available did not permit determination of the mechanisms responsible for observed interactions.

V. Major Publications: (1969-1970)

Pahnish, O. F. 1970. Crossbreeding. The Montana Stockgrower 42(1): 22-23.

Pahnish, O. F. 1970. Current status of crossbreeding research. Beef Cattle Field Day Proc., U. S. Range Livestock Experiment Station, Miles City, Mont. pp. 1-11.

Pahnish, O. F. 1970. Postweaning performance of first-cross steers. J. Animal Sci. (Abstract. Accepted for publication)

Pahnish, O. F. 1970. Some observations on Brown Swiss breeding used in production of beef calves. Proc. National Association of Animal Breeders. (In press.)

Urick, J. J. 1970. Some body weight relationships in cows and calves raised on the range. Beef Cattle Field Day Proc., U. S. Range Livestock Experiment Station, Miles City, Mont. pp. 30-33.

VI. Application of Results:

1. From the earlier studies at the Miles City Station some important procedures were developed and recommended to the industry for the improvement of beef cattle. Findings on inheritance of economically important traits contributed to the development of these procedures. Because the postweaning growth traits to yearling age were established as being highly heritable they were considered important in recommending certain selection procedures. Bull indexing from weaning to about 12 months and heifer selection at 18 months were two practices that were put into use and are now being applied widely in the industry to improve herd production for growth.

2. Evidence indicated that inheritance contributes to the incidence of cancer eye, vaginal and uterine prolapse, and bloating tendency. Stockmen were encouraged to cull closely for these weaknesses. Reproductive performance of heifers during their first year in the breeding herd was found indicative of subsequent reproductive performance. The practice of culling shy breeding heifers was, therefore, recommended to increase herd production.

3. Among variables found to affect performance of growing cattle materially were age of dam, age of calf and sex. Adjustments for these factors were determined and recommended for use as appropriate in evaluating animals for genetic merit within or between years.

4. Positive responses to selection were obtained for most growth traits in one mildly inbred line with fairly large numbers and fairly intense selection (most heavily on the sire side). The results in this line suggest that the selection procedures used should be effective for increasing herd production.

Comparisons of all 14 lines formed and developed at the Station showed that inbred lines varied widely in their performance; some exhibiting superior maternal qualities while others excelled in growth. The three lines formed from crosses of inbred lines generally excelled in most all growth traits to maturity.

A recent study to estimate hybrid vigor from crossing five inbred lines showed advantages in the linecross progeny as evidenced by increased growth to weaning and during the postweaning gain test to yearling age. The linecross females when carried to breeding age showed increased maternal performance over the straightlines. A line's own record was a fairly good indication of its subsequent performance in a line crossing program. Thus, the evidence so far suggested that the practice of using sires from high performance lines in top crossing should increase production in commercial herds.

5. From some estimates of phenotypic and genetic relationships studied in this herd, the correlated response between final weight and other growth traits was high enough in both bulls and heifers to indicate it would be an effective single trait for which to select. There was little correlated response in desired carcass traits from selection for preslaughter traits.

6. Some estimates of hybrid vigor were obtained in the crossbreeding study with Angus, Hereford and Charolais breeds. Generally hybrid vigor reached a peak at weaning in both male and female calves and deminished thereafter. There was very little evidence of heterosis in carcass grade in steers or postweaning growth traits in the heifers. Steers exhibited more heterosis than heifers.

Crossbred females showed some advantage over straightbreds in maternal characteristics as evidenced by an increased weaning weight of calf produced per cow bred. The overall economic benefits from crossing beef breeds to date seem important enough that segments of the industry have been encouraged to follow similar crossbreeding schemes.

Limited data from crossing beef sires X Brown Swiss dams showed an advantage in weaning weights for the calves as compared to those from beef X beef females. Beef X Brown Swiss steer carcasses graded almost as high as those from beef crossbreds, but beef X Brown Swiss steers were graded lower on the hoof at slaughter time. The live grades did not accurately reflect carcass grade.

Beef X Brown Swiss females produced somewhat more calf weaning weight per exposed cow than beef crossbreds. Thus, under certain environments, beef X dairy crossing programs show promise for increasing total calf production to weaning. Increasing size in cows within the beef breeds did not increase calf weaning weight to an important degree.

7. An adaptation study was initiated with the transfer of two Hereford lines between the Montana and Florida Experiment Stations in 1961. The results to date showed that there were location-origin interactions. This was most evident in most weights and gains to yearling age. The herd of Florida origin showed advantages in percent of cows pregnant and net calf crop weaned at both locations, but this was most evident in Florida. Information to date indicates that at least some stocks perform relatively better in the location of origin than in other locations where environments is decidedly different.

UNIVERSITY OF NEVADA

I. Station: Nevada Agricultural Experiment Station

II. Project titles:

The effect of environment on selection for traits of economic importance; the relative value of several selection criteria; and reproductive studies in range beef cattle.

Interactions between genotype and environment in selection for economically important traits in Hereford cattle.

Moderate inbreeding with the Hereford breed using weight correlated with age and conformation, plus natural vigor and fertility as a yardstick for line selection.

The effect of genetic-environmental interactions on selection responses.

III. Personnel:

Experiment Station:
C. M. Bailey, Project Leader, R. J. Almgreen, J. E. Hunter, and C. R. Torell

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado:
Bradford W. Knapp, Acting Investigations Leader

IV. Major Accomplishments:

Selection For Single Traits

Five closed, single-trait Hereford lines were established at two locations in Nevada in 1955. All progeny of both sexes were fed individually for 140 days postweaning. At one location (Line 1, postweaning gain; Line 2, feed efficiency; Line 3, yearling conformation) calves received 2 parts grass hay: 1 part concentrate during the postweaning period. Progeny at the other location (Line 4, gain; Line 5, feed efficiency) were fed a supplement plus grass hay *ad libitum*.

Inbreeding caused a reduction in performance of progeny under both sets of conditions. Maximum likelihood estimates of genetic trends based on differences between dam birth year groups indicated that positive changes had occurred in gain and gain/TDN in all lines during the period 1955 to 1969 (N = 1403), although linear effects on these traits were statistically significant only in Line 4. Estimates of genetic changes in conformation score, with effects of body weight

removed were minimal. Regression of gain/TDN on dam birth year in the gain lines were of about the same order of magnitude, or somewhat higher, as compared to values for lines in which direct selection was practiced for increased feed efficiency, suggesting that many of the genes which determine the expression of growth rate of beef cattle are responsible also for efficiency of feed utilization.

Comparative slaughter trials were conducted in 1965, 1966 and 1967 to evaluate efficiency of energy utilization of line progenies. Random groups of bulls were slaughtered at the conclusion of 140-day, postweaning tests; the remaining bulls received a fattening ration until a weight of 450 kg was attained. Means for Mcal carcass energy gain/100 Mcal DE above maintenance of Lines 1, 2, 3, 4, 5, respectively, were: 13.32, 14.38, 15.97, 17.78, 17.32.

Upon completion of 140-day tests in 1968 and 1969, yearling bulls in Lines 1, 2 and 3 were allotted at random to two feeding levels and slaughtered at approximately 458 kg. There was no difference among the three lines in feedlot gain, although bulls in the conformation line (Line 3) were somewhat fatter and exceeded the other two lines in terms of area of longissimus muscle/100 kg carcass. Line X feeding level interactions in gain and carcass characteristics were nonsignificant.

Four sets of bulls from selection lines at both locations were entered in the regional sire testing program at the Arizona Station, but progeny data are not available at this time.

Relationship Between Performance and Carcass Traits

A study of associations among production factors, conformation scores, body measurements and carcass traits of yearling steers showed that (1) there is little, if any, relation between feeder grade and subsequent rate or economy of gain, (2) there is a high relation between slaughter score and carcass score, carcass price, and percent bone, muscle and fat in the 9-10-11 rib, (3) feeder measures bear little relation to production or carcass traits, (4) relations between slaughter measures and carcass traits are generally low, and (5) carcass grade is largely a function of percent of fat in the carcass.

Feasibility Studies on Bull Beef Production

Under the conditions of these studies, bulls were comparable to steers in preweaning growth rate. Bulls were more efficient in the feedlot than steers and produced leaner carcasses. Steer carcasses were superior in marbling and grade; longissimus muscle of steers was slightly more tender than muscle from bulls. Differences in daily gain, feed efficiency and in tenderness and flavor of longissimus muscle of bulls and stilbestrol-implanted steers were nonsignificant.

Small Animal Studies

The 16 possible combinations including inbreds and reciprocal crosses were made among four inbred lines of rats. Effects of sex, line and maternal ability were highly significant for body weight at 28 and 70 days. Heterosis was significant at 70 but not at 28 days. General combining ability was highly significant at 28 but not at 70 days. There was no evidence of specific combining ability or sex linkage effects.

In other pilot studies, six lines of rats were maintained under two nutritional regimens for six generations: Three of the lines received a commercial ("regular") laboratory diet continuously; individuals in the other three lines were fed a "restricted" diet consisting of 45% cellulose: 55% commercial diet from 28 to 70 days of age. Both diets were offered ad libitum. Mass selection was practiced for post-weaning growth rate in two lines on each diet and two lines served as controls. Top-gaining, select-line males produced in the final generation were mated with control dams on both diets for evaluation of the effects of sire line X nutritional regimen interaction on growth rate, feed efficiency and body composition of progeny.

Selection resulted in a significant increase in growth rate of rats under both nutritional regimens. There was evidence of a positive genetic relation of gain with weights at 70 and 100 days of age but selection for postweaning gain had no effect on preweaning growth rate. Realized heritability estimates of postweaning gain were 0.38 ± .11 and 0.32 ± .09 for regular diet select lines and 0.17 ± .10 and 0.28 ± .10 for replicate select lines on the restricted regimen. Progeny of top-gaining sires from the regular diet select lines were clearly superior in performance as compared to those sired by breeding stocks with a history of selection under restricted feeding. Sire line differences in percent dry matter, percent ash and kcal energy per unit of carcass tissue were nonsignificant. In each of the four lines the rank of sires varied according to the nutritional regimen under which progeny were evaluated; however, effects of sire line X nutritional regimen interaction on postweaning growth rate, feed conversion and carcass components were negligible.

V. Major Publications: (1969-1970)

Bailey, C. M., S. P. Hammack, W. R. Harvey and C. L. Probert. 1969. Sire line X nutritional regimen effects on growth rate, feed efficiency and carcass composition. (Abs. 8) J. Anim. Sci. 29(1):104.

Bailey, C. M. and R. J. Almgreen. 1970. Line X feeding level effects on gain and carcass characteristics of yearling Hereford bulls. Proc. West. Sect. Amer. Soc. Animal Sci. 21:351. [(Abs. 12) J. Anim. Sci. 30([illegible]):1032.]

Bailey, C. M., S. P. Hammack, W. R. Harvey and C. L. Probert. 1970. Sire line X nutritional regimen interaction: Effects on postweaning performance of the rat. J. Anim. Sci. 30(3):337.

VI. Application of Results:

Estimates of genetic changes derived from the beef cattle selection study are subject to large sampling errors; however, the results do indicate that selection for postweaning growth traits is effective. Evidently, weight-for-age was a chief factor in evaluating yearling conformation since changes in the score were minimal with body weight held constant. The positive genetic trends in feed efficiency in lines in which direct selection was for postweaning gain are generally consistent with earlier estimates of genetic association between growth rate and measures of feed efficiency; thus, current recommendations against the extensive use of individual feeding appear to be justified.

Research findings from the W-1 project have been utilized in establishing test procedures for the Nevada Beef Cattle Improvement Association.

Feeder scores have little relation to production traits and live animal measurements are relatively poor indicators of carcass value. Slaughter scores may be useful in predicting carcass grade and composition of the 9-10-11 rib.

Beef from young bulls which have been finished on high concentrate rations and slaughtered at approximately 14 months of age appears to be acceptable in palatability. Adoption of bull beef production by industry would result in substantive increases in the yield of lean cuts of market cattle. Although young bulls have a clear-cut advantage in feedlot performance as compared to untreated steers, differences between stilbestrol-treated steers and bulls in these characteristics are much less pronounced. The majority of steers in feedlots in the United States are treated with stilbestrol; hence, it seems unlikely that <u>major</u> reductions in feed costs can be achieved by converting to a bull beef program.

The results of the small animal studies show that selection was more effective on a "regular" diet than under conditions of "restricted" feeding. Specific adaptation effects of sire lines on progeny performance were of little or no importance. It should be noted that in this study both diets were offered *ad libitum*. Thus, factors such as appetite, feed capacity and utilization of nutrients may have had a similar role in selection for growth rate under both nutritional regimens.

NEW MEXICO STATE UNIVERSITY

I. <u>Station</u>: New Mexico Agricultural Experiment Station

II. <u>Project title</u>: Inheritance of heart defects and evaluation of factors affecting production and anomalous traits in beef cattle.

III. <u>Personnel</u>:

Experiment Station:
L. A. Holland, Project Leader, T. H. Belling, Jr., R. L. Blackwell, Estel H. Cobb, R. M. Durham, Marvin Koger, J. H. Knox, J. D. Mankin, A. L. Neumann, E. E. Ray, D. W. Zinn, Elmer Allen, L. [illegible]. Brown, Stewart Floyd, E. Forehand, Agustin Franco A., J. A. Gosey, T. H. Hall, F. E. Harrington, F. G. Heckman, F. A. Hudson, Paul Hurt, David Kirkpatrick, N. D. McCleery, J. V. Moore, Anthony Romo, Mario Schwartz, and C. E. Sciacca.

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado:
Bradford W. Knapp, Acting Investigations Leader

IV. <u>Major Accomplishments</u>:

<u>Type Studies</u>.

Steers classified as rangy at the start of a feeding period weighed more, gained more, and yielded a higher dressing percentage than the small-type steers, with medium type intermediate in each case. These results indicate that the development of rapid gaining strains will be more difficult if size is reduced by restricting height and length to secure compactness.

Large-type cows produced a larger percent calf crop over a longer productive life and the calves weighed more at weaning than calves from compact cows. The average lifetime production was 5.0 calves from the compact cows and [illegible].5 calves from the large-type cows. Average weight of calf produced per year of cow in the herd was 340 pounds for the compact cows and 440 pounds for the large-type cows. On the basis of calf production per 1,000 pounds of cow, the large-type cows averaged 413 pounds and the compact cows averaged 3[illegible] pounds.

<u>Weaning Traits Under Range Conditions</u>.

The need for adjusting weaning weights for age-of-calf, sex-of-calf and age of dam to increase accuracy of selection was pointed out in studies in the 1940's. The choice of 205 days as the age to adjust calf weaning weights widely used in the industry probably is a result of that age being used in a publication from this station.

Weight and grade at weaning of Hereford and Angus calves were determined to be moderately heritable. Estimates of repeatabilities of weaning weight and weaning grade indicate that considerable progress can be made in selecting breeding range cows on the basis of the first calf record, and that differences in the inherent producing abilities of cows frequently may need to be considered in making group comparisons.

Inbreeding of calf depressed weaning weight, negative partial regression coefficients of weaning weight on inbreeding of the calf being -0.74, -1.19, and 0.63 pounds per one percent inbreeding in three different analyses. Negative regressions of weaning grade on inbreeding of calf were so small that the effect of inbreeding was considered unimportant. Partial regressions of weaning weight and grade on inbreeding of dam were positive.

Yearling Traits Under Range Conditions.

Heritabilities of 18 months weight were 0.10 and 0.71 for steers and heifers, respectively, while the estimates for yearling gain were both 0.32.

The estimated heritabilities of grade at 18 months were 0.34 and 0.40 for steers and heifers respectively.

Feedlot Traits.

The estimate of heritability of daily gain of steers in feedlots for 168 days and about 2 years of age was 0.70. Final weight at the end of the feeding period was estimated to be 70% heritable. The estimate of heritability of slaughter grade was 0.38.

Carcass Traits.

Estimates of heritabilities of carcass traits of 2 year old steers fed 168 days were: dressing percent, 0.25; and carcass grade, 0.59. Zero estimates of heritability of these traits were computed for another study based upon smaller numbers and the steers were slaughtered at about 15 months of age.

Correlations Between Live and Carcass Traits.

Live animal measurements were lowly related to carcass traits.

Calving Interval.

Estimates of heritability and repeatability of calving interval in an Angus herd maintained under range conditions were zero.

Intensity of Red Color in Hereford Cattle.

Heritability of intensity of red color in Hereford cattle was estimated from intra-sire regression of offspring on dam to be 73.1 percent and from regression on mid-parent to be 74.7 percent. However, phenotypic correlations of intensity of red color with measures of range performance, feedlot performance, and carcass merit were not significantly different from zero.

Cancer Eye.

Heritability estimates for susceptibility to cancer eye ranged from 0.17 to 0.30 in Hereford cattle. Cancer eye first appeared in Herefords at four years of age and the incidence increased with age thereafter.

Vaginal Prolapse.

Vaginal prolapse was exhibited by 34 of 150 cows leaving a purebred Hereford herd maintained under farm conditions. None of 400 cows of similar breeding raised under ranch conditions exhibited the condition. Within the environment in which vaginal prolapse was expressed, heritability estimates were 0.57 and 0.14.

Circulatory Defects.

Failure to produce ventricular septal and patent ductus arteriosus defects in planned matings, led to the conclusion that these defects are not simply inherited.

Hydrocephalus.

Hydrocephalus was described and postulated as being due to a single autosomal recessive gene. Decreased frequencies of hydrocephalic calves in the experimental herd and a private herd resulted from selection against the defect based upon pedigree and progeny tests.

Closed Lines.

A purebred Hereford herd, originally established as a teaching herd, served also as a research herd upon entrance of this station into the W-1 project. The herd was closed to outside breeding in 1932. An unrelated bull sired a few calves in 1941 and 1942. In the early 1950's hydrocephalic calves, all tracing to the introduced bull, were born. Consequently, in 1952 two lines were formed: an "outcross" line, all animals related to the introduced bull; and the "old" line consisting of animals not related to the bull. These lines remained closed and crosses were not made between them until 1964. Observation of a ventricular septal defect among animals in

both lines and of a single patent ductus arteriosus defect in the "Old" line led to a change in procedures to permit testing the inheritance of these defects in 1964. Results that follow are based upon reproductive data gathered from 1933 through 1964 and upon production data collected from 1948 through 1964.

The cattle were maintained under farm conditions, calving year round with calving first at 2 years of age, and weaning at an average of 243 days of age.

In an analysis of 999 matings during the year 1933 through 1964, 5.5% of the cows did not calve, 2% aborted fetuses, 5.7% presented dead calves, 3.7% of the calves born alive died before weaning time, .7% of the matings resulted in abnormal calves (hydrocephalus), and 82.4% of the matings resulted in live calves at weaning. Greater death loss among calves out of 2-year old dams caused significant age-of-dam differences in percent calf crop weaned. Season of birth did not significantly affect percent calf crop weaned. Death loss among twins was greater than death loss among single births. Levels of inbreeding of dam and calf did not significantly affect percent calf crop weaned.

Least squares analyses were conducted to determine the effects of years, age-of-dam, inbreeding of dam and inbreeding of calf upon birth weight, weaning grade, weaning condition and weaning weight. Analyses were computed separately for sexes and lines.

Year effects for birth weight were non-significant but highly significant for grade, condition score and weight. Age-of-dam effects on birth weight were significant for "Old" line males and females but non-significant in the analyses of "Outcross" line males and females.

Inbreeding of dam did not significantly affect any of the traits. Inbreeding of calf significantly affected birth weights of male and female outcross calves but did not significantly affect grade, condition, or weaning weight.

Effects of line and level of inbreeding were determined on final weight, feed efficiency, and daily gain of 65 bulls on 140-day test. The old line bulls had significantly faster daily gains and final weight than the outcross line bulls. The difference in feed efficiency between the lines was not significant. The negative regression of feed efficiency on inbreeding coefficient was not significant. Inbreeding did depress final weight, a 1% increase in inbreeding causing a loss in final weight of 5.1 pounds.

Repeatabilities of traits were weaning weight, 0.24; condition, 0.41; and conformation, 0.14. Most probable producing abilities for all three weaning traits of cows out of young or old dams were higher than those of cows out of intermediate age dams.

Data from these lines were used to determine heritabilities of intensity of red color, resistance to cancer eye, resistance to vaginal prolapse, and to determine inheritance of hydrocephalus, ventricular septal defect and patent ductus arteriosus which are discussed in preceding sections.

The "Outcross" line has been discarded. The "Old" line is presently being maintained under both farm and ranch conditions. This line is believed to have sufficient merit to be used in line crosses or in crossbreeding programs.

<u>Regional and Interregional Co-operation.</u>

Four bulls out of the "Old" line were used in the line evaluation study conducted by the Arizona Agriculture Experiment Station. Three bulls out of the line were used in line evaluation study conducted by the Mississippi Agriculture Experiment Station.

Rib steaks of steers were supplied to the Colorado Station for their project on fatty acid content.

V. <u>Major Publications:</u> (1969-1970)

Ellicott, G. H., L. A. Holland, and A. L. Neumann. 1970. Most probable producing ability of Hereford cows. Proceedings, Western Section,American Society of Animal Science 21:313. [(Abs. 5) J. Anim. Sci. 30(6):1030]

VI. <u>Application of Results:</u>

1. Results of type studies showing that small type cattle are not as productive on the range and in the feedlot as large type cattle, though not accepted immediately by industry, has lately become accepted.

2. Adjustment of weaning weight for effects of age-of-dam, sex-of-calf and age-of-calf to increase accuracy of selection has been widely adopted in industry.

3. Estimates of heritabilities of reproduction and production traits from this and other station have been used by breeders to decide upon relative emphasis to place on traits in selection.

4. The extent to which selection against cancer eye has been influenced nationally is not known, but in New Mexico many ranchers have been selecting against cancer eye since they learned that susceptibility of resistance to it has a heritable basis.

5. The description of hydrocephalus has aided ranchers in identifying this defect and the knowledge of its simple recessive mode of inheritance has been used in breeding programs throughout the nation.

6. Knowledge of the inheritance of vaginal prolapse and lack of inheritance of the ventricular septal defect and patent ductus arteriosus defect will be useful to breeders encountering these defects.

7. Inbreeding did not cause severe depression of levels of reproduction and production within closed lines thereby giving encouragement to more close matings within privately owned purebred herds.

OREGON STATE UNIVERSITY

I. Station: Oregon Agricultural Experiment Station

II. Project title: Diallel crossing in beef cattle and its use in breed improvement.

III. Personnel:

Experiment Station:
Ralph Bogart, Project Leader, A. F. Anglemeir, Harry Avery, L. D. Calvin, R. B. Gysbers, H. B. Howell, Farris Hubbert, Jr., W. K. Johnston, John Kaufmes, W. H. Kennick, H. H. Krueger, A. C. Mackey, J. A. B. McArthur, C. D. Pierce, A. W. Oliver, R. J. Raleigh, A. T. Ralston, K. E. Rowe, W. A. Sawyer, W. C. Van Arsdel, J. D. Wallace, A. C. Warnick, G. I. Alexander, F. R. Ampy, M. Anwar-Afghan, Tim Bhannasiri, M. J. Burris, R. C. de Baca, F. K. Hoornbeek, P. E. Humes, M. A. MacDonald, R. W. Mason, G. E. Nelms, Hugh Nicholson, O. F. Pahnish, Moti Pinjani, D. A. Price, S. W. Sabin, J. W. Templeton, C. E. Williams, R. L. Blackwell, J. J. Dahmen, Glen Hitchcock, F. K. Hoornbeek, C. E. Pierce, H. K. Turner, Marcus Munji.

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado:
R. T. Clark, J. S. Brinks, Bradford Knapp, and C. E. Shelby,

IV. Major Accomplishments:

The major accomplishments are presented according to areas of work that have been done rather than according to years during which the research was done.

1. Stimulation of rate and efficiency of gains by testosterone injections.

The intramuscular administration of testosterone at the rate of 1 mg. per kg. body weight per week caused heifers to gain approximately 0.227 kg. per day more than control heifers and require 1.02 kg. less feed per kg. gain than control heifers. The difference between control and testosterone-injected steers was .07 kg. per day greater gain with .272 kg. less feed per kg. gain for the testosterone-treated than for the control steers.

Testosterone administration caused marked masculinization as shown by crest development, male-like attitude toward other females, darkening of the red coat color, and bellowing like a bull. It was learned from injecting heifers with testosterone that ovulation was inhibited in most of them but when treatment was withheld, the females came into heat within a few days and became pregnant when they were bred.

The injected testosterone was shown to cross the extra-embryonic membranes and get into the circulation of the fetus of cows that were given injected testosterone. One female calf born to a cow given testosterone was a marked case of "Freemartin" due to the testosterone getting into her system.

A material, methostan (methyl androstenediol), which has no masculinization effects was used but it was also ineffective in stimulating rate and efficiency of gains.

Testosterone injections caused a marked increase in lean and a marked decrease in fat in the carcasses of the animals when compared with control animals. Animals receiving testosterone injections showed greater cell height of the thyroid follicles and had a higher thyrotropic and growth hormone content of the anterior pituitary than control animals.

2. <u>Blood chemical studies related to rate and efficiency of gains.</u>

It is extremely difficult to study metabolism of ruminants because a basal metabolic measurement is not obtainable on a normal animal since there is always material from the rumen moving through the rest of the digestive tract. Studies can be made of precursors and end products of metabolism that are present in the blood. Studies were made on calves at each 45.4 kg. increment in body weight starting at 45.4 kg. and continuing to 353.2 kg. body weight. The material studied were urea and amino acid nitrogen, creatine, creatinine, uric acid and ammonia nitrogen concentration. The more rapidly gaining calves were low in urea and amino acid nitrogen levels while the less rapidly gaining and less efficient animals were high in these blood constituents. Heifers were consistently higher than bulls in blood levels and amino acid and urea nitrogen and they gained less rapidly and required more feed per unit of gain. The more rapidly gaining and efficient animals had a higher percentage of lean and a lower percentage of fat in the carcass than the less rapidly gaining animals. It appeared that rapidly gaining animals have the capacity to withdraw amino acids from the blood stream for building muscle tissue. The less rapidly gaining animals, on the other hand, do not have a great capacity for withdrawing amino acids from the blood for building muscle tissue; therefore, they are faced with the problem of eliminating the amino acids. This is done by deaminizing the amino acids, converting the nitrogeneous portion into urea which is excreted through the urine and utilizing the carbonaceous portion as a source of energy for fattening.

3. <u>Enzyme studies related to rate and efficiency of gains.</u>

Since it has been shown that the more rapidly gaining calves have greater capacity for withdrawing amino acids from the blood stream for building muscle tissue, it appeared that certain enzyme

systems would be involved. Serum levels of alkaline and acid phosphatase activity, serum glutamic-oxalacetic transaminase and serum glutamic-pyruvic transaminase activity, serum amylase activity and liver nicotinamide adenine dinucleotide coenzyme activity were determined to see if they were related to rate and efficiency of gains. The transaminase and amylase enzyme activities were not related to rate and efficiency of gains. Alkaline phosphatase activity and the ratio of alkaline to acid phosphatase activity were related to rate and efficiency of gain. In addition, the better doing calves showed a more uniform level of activity of these enzymes than slowly gaining animals. These enzymes would be expected to be associated with bone growth. The liver nicotinamide adenine denucleotide coenzyme level of activity should be concerned with fat metabolism. The animals used for the study on coenzymes were all bulls at 454 kg. body weight. Animals that reached 454 kg. at a younger age (grew more rapidly) were lower in coenzymes that are positively associated with higher fat content in the carcasses. Also, more rapidly gaining animals had larger thyroids and contained more lean and less fat in the carcass. Inbred animals grew less rapidly, had smaller thyroid glands, had more fat and less lean in the carcass, and showed greater coenzyme activity. It appears that the coenzymes that are concerned with fat deposition encourage slower growth and more fat and less lean in the carcass. There is the possibility that thyroid activity may determine the coenzyme level of activity which in turn governs the type of body tissue which is deposited.

4. Blood cellular constituents.

It has been shown that hemoglobin per unit volume of blood, concentration and content per red cell increases as calves increase in size and age. Rapidly gaining and efficient calves are lower in hemoglobin than slowly gaining animals. Bulls are lower in hemoglobin than heifers of the same weight. It appears that the increase in amino acid and urea nitrogen levels in the blood (which is outside the red blood cells) of animals as they increase in size and the increase in hemoglobin (which is inside the red blood cells) as calve increase in size tends to maintain an isotomic relation between the red blood cells and the medium in which they are present (the plasma).

5. Inbreeding and selection effects.

Three lines of Herefords consisting of one sire and 15 cows and one line of Angus consisting of two sires and 20-25 cows were developed as closed populations using rigid selection for suckling gains, feed-test rate and efficiency of gains, fertility, score for conformation and freedom from inherited defects. Selection was effective in improving rate and efficiency of gains and conformation score initially in the Hereford (one-sire) lines after which there was a plateau followed by a decline. In the Angus line (two-sire and 20-25 cows),

improvement has been, and is continuing to be, made in all production characteristics. The data showed that unconscious selection has been practiced against inbreeding. Inbreeding affected preweaning traits more quickly and severely than it did the post-weaning traits. For example, selection was not able to overcome the inbreeding depression in suckling gains in the three Hereford (one-sire) lines even in the early phases of the program. Inbreeding did not appear to have a detrimental effect on feed-test rate and efficiency of gains but it must be remembered that only 20-30% average inbreeding was reached in the lines.

The three Hereford lines have been crossed in all possible ways by a diallel mating plan. There has been some evidence for heterosis and for general and specific combining ability effects but the largest heterotic effect was in calf survival at birth. Approximately 13% of the inbred calves died at birth while 3-5% of the linecross calves failed to survive even though fertility level was the same in the outbred and the inbred calves. This difference is of particular interest since all calves were produced by inbred dams because it shows that survival was related to the genotype of the calf.

Selection in the four lines was studied along with changes resulting from selection. It was noted that positive selection was evident for all traits on the sire side and for some traits on the dam side. In general, selection was positive for the traits and it was greatest in the Angus. By intra-sire regression of offspring on dam (corrected for sex of offspring), the heritability estimates for suckling gains were zero, for post-weaning gain were from 22-40%, for feed per unit of gain were from 21-40% and for conformation score were from 0-31%.

Bulls from the three Hereford lines have been used on commercial cows and data have been obtained on the calves they sired. The performance of top-cross calves showed that the traits that characterized the lines were generally expressed in the top-cross calves. For example, the line 2 cattle were exceptionally efficient in feed use and calves sired by bulls of this line were also quite efficient in feed use.

In the feed testing program, it was desirable to have a ration such that, what the calves ate and what they did not eat, would be the same; consequently, a completely pelleted ration composed of two parts half-cut hay to one part of concentrate mixture was developed. It was found that this ration had a 65% digestibility but some of the calves (about 4%) expressed chronic bloating on this ration. Bloating animals were intermated and mated to close relatives (son x dam and full sib) to see if the chronic bloating tendency is under genetic control. The calves from these matings showed 65% chronic bloating compared with 4% for the herd in general. This indicates that chronic bloating tendency is highly heritable (65%).

6. Heritability estimates under different feeding levels.

Heritability estimates have been determined under a wintering and a full-feeding program for rate and efficiency of gains. It was found that very low or non-existing values were obtained on wintering rations where calves gained approximately .227 kg. per day whereas moderate to high values were obtained when parents and offspring were full fed and made gains of .9 kg. or more per day.

7. Factors associated with performance traits.

In practically all studies conducted, it has been noted that there were large yearly differences in performance traits. Age of dam has been shown to have a large effect on suckling gains or weaning weight. Young cows wean calves about 34 kg. lighter in weight than when they become mature. Also, as cows age (10-20 years old), the weight of their calves at weaning becomes less.

Bulls gain more rapidly than heifers both during the nursing and during the post-weaning periods. If range or pasture conditions are better, there are more marked differences between bulls and heifers in suckling gains but if pasture conditions are inferior, no sex difference is apparent in suckling gains. Rate of gain and feed efficiency are highly correlated as has been shown by simple correlation coefficients of 0.80 to 0.85 each year over a 22-year period at this station.

Although bulls gain more rapidly than heifers during the feed test, they consume no more feed per unit of body weight than heifers; consequently, they are much more efficient in feed use than heifers. There is usually two to four kg. less feed required per kg. gain in bulls than in heifers.

It was found that our four lines differed in suckling and post-weaning gains and in feed efficiency. The Angus cows apparently are heavier milkers because suckling gains have always been much greater in the Angus than in the Hereford calves. The line 3 Herefords made the lowest suckling and the highest post-weaning gains. There appears to be some compensatory effects in post-weaning gains and efficiency for preweaning effects. The line 2 animals were consistently highest in feed efficiency.

A great deal of the variation in feed required per unit of gain is accounted for by variations in daily gains and daily feed consumption. Also, much of the variation in daily gain is accounted for by variations in daily feed consumed and feed required per unit of gain. Daily feed consumption showed a heritability estimate of 30%.

It has been noted that size of dam influences suckling gains of the calf even when the cows are of the same age. Larger cows wean

larger calves that gain more rapidly during the feed test period and require less feed per unit of gain.

Studies have shown that the first and the last calves born during a 60-90 day calving season do not do as well as the other calves. It appears that some of the earlier calves get a setback because there is not sufficient grass to make the cows give sufficient milk. Some of the later born calves are small at the time the grass dries up and they are not sufficiently developed to do well on dry forage but they are forced to live on this because their dams do not give much milk on dry forage.

It was not possible to establish a relationship between changes in weight of cows and gaining ability of their calves although one might expect that heavier milking cows would lose weight while nursing their calves.

8. Electrocardiograms of beef cattle.

Normal EKG patterns for beef cattle have been established and also the best leads for obtaining interpretable EKG recordings have been ascertained. The changes that occur in the EKG pattern from birth to maturity and the effects of certain factors such as diet, temperature, etc. have been determined. This background information has made it possible to determine what the heart condition was like in certain abnormal animals by the electrocardiographic pattern. It has been amazing how accurately the condition of the heart was predicted as evidenced from slaughter of some of the animals that had heart abnormalities. The electrocardiographic studies indicated that selection for greater muscular mass produced over a shorter period of time may be creating beef animals that are dangerously close to a condition in which the heart may not be able to meet the needs of the animal; particularly if the animal is put under exercise stress.

9. Effect of nutrition on protein hormone production.

One study was made in which the thyrotrophic hormone content of the pituitary gland was determined from steers fed a normal and those fed a protein low diet. No differences in this proteinaceous hormone were found; therefore, it must be concluded that normal variations in diet of beef cattle do not influence protein-hormone production.

10. Relation of scores and body measurements to performance traits.

Every animal has been scored for conformation and condition at the end of the feed test and most animals have been scored at the beginning of the feed test. Body measurements, including length, width and depth of body; circumference of heart and paunch; and rump and round measurements have been taken at the beginning and at the end of the

feed test. Analyses showed that scores at the beginning of the test had no relationship with subsequent rate and efficiency of gains but they were related to how well the calves had done during the nursing period. Scores for conformation at the end of the feed test were positively related to the previous rate of gain.

Body measurements did not provide any information that was not provided by body weight. There were not significant relations observed between scores and measurements.

11. Growth curves.

Since weights have been regularly taken every two weeks on all animals from birth until the end of the feed test, it appeared that one could develop a mathematical description of growth in young beef animals. The first, second, third, fourth and fifth degree parabolas were calculated for each calf. Significant changes in slopes of the growth curve were found for each of the degrees. In general, calves that gained at a rapid rate showed few or no changes in slope of the growth curve whereas animals gaining at an intermediate or low rate showed much greater changes in the slope of growth curve. It appeared that one of the reasons for some animals having a low rate of gain for the entire period is their lack of consistency in rapid rate of gains. There were some animals that gained at a uniformly low rate but there were also some that gained rapidly at times but exceedingly slowly at other times.

At present, attempts are being made to develop a better method of describing growth because the parabola method does not allow comparisons to be made among all the animals.

V. Major Publications: (1969-1970)

Humes, P. E., Ralph Bogart and Prentiss Schilling. 1969. Preweaning performance of linecross beef calves. (Abs. 22) J. Anim. Sci. 29(1):108.

Bogart, Ralph. 1969. Crossbreeding beef cattle will pay. A. I. Digest 18:3,7, 14. (Ore.'s Agric. Program Quarterly, Spring, 17(1):3, 5, 10.)

Anwar-Afghan, M., R. Bull, Ralph Bogart and J. E. Womack. The relationship of liver nicotinamide nucleotide coenzymes to production traits in diallel crossed beef bulls. J. Anim. Sci. (accepted for publication).

Bogart, Ralph. The role of the purebred Angus breeder in changing commercial production programs. Angus Journal. (article accepted for publication).

Bogart, Ralph and N. C. England. Feed consumption, daily gain and feed required per unit of gain in beef calves. J. Anim. Sci. (accepted for publication).

VI. Application of Results:

1. The work at Oregon State and other state stations showed that there was great variability in performance traits of beef cattle and that these traits responded to selection based on accurate records; therefore, many ranchers in Oregon have developed a beef cattle improvement program on their ranches and are basing selection soundly on performance records.

2. The crossing of the fetal membranes by administered testosterone in beef cattle which resulted in great modification of the genitalia of female fetuses was reported to the International Fertility Association meeting in Monterey, Mexico which put the medical practitioners on the alert. It was soon observed that this also happens in the human; consequently, the use of testosterone for increasing nitrogen retention has been restricted to women that are past the reproductive age.

3. It has been shown that more rapidly gaining animals, whether testosterone treated or because of genotype, store more lean and less fat in the carcass. Thus, selection for increased rate of gain should reduce excess fat and increase carcass lean.

4. Better gaining calves are lower in blood amino acid and urea nitrogen levels. It may be possible to develop chemical methods either for early selection prior to the feed test period or for increasing the accuracy of selection. Better gaining calves resemble younger animals whereas slowly gaining calves resemble older animals in their metabolism.

5. Alkaline phosphatase activity is positively related with more rapid and economical gains. Liver nicotinamide adenine dinucleotide coenzyme activity is related to increased fattening. The coenzyme activity is positively related to fat of the carcass and negatively related to lean of the carcass and to thyroid gland weight. This information adds to our knowledge of beef cattle physiology and on how genes are acting. It may be possible to use this information in selecting beef cattle.

6. Inbreeding not only reduces rate of gain but it causes animals to store more fat and less lean in the carcass. It appears that crossbreeding might have an added value in reducing waste fat and producing a greater proportion of lean. Linecross calves raised by inbred dams showed a much higher survival rate at birth than inbred calves. It appears that a crossbreeding program could be expected to result in a significantly higher percentage of calves raised.

Inbreeding affected preweaning more severely than post-weaning gains. It was found that selection was effective in preventing the depressing effects of inbreeding in a two-sire and 22-25 cow herd but not in one-sire and 15 cow lines. Thus, if closed-herd bred populations are to be maintained for use in a crossing program, herd size will have to be considered.

7. In general, sires from a closed herd transmit their outstanding good and bad characteristics as well as providing a basis for obtaining hybrid vigor in crossing.

8. Heritability estimates of rate and efficiency of gains of 21-40% show that these traits will respond to selection. It has also been shown that the tendency for chronic bloating is highly heritable; consequently, breeders should avoid the use of animals for breeding if they are chronic bloaters.

9. Heritability for rate and efficiency of gains was low or not existent when the animals were fed to gain only .227 kg. per day but were high (40-50%) when animals were fed to gain .908 kg. per day. It appears that if improvement is to be made through selection, a feeding rate must be sufficiently high for animals to express genetic differences.

10. Scores for conformation were not indicative of how a calf will subsequently gain. If improvement in rate and efficiency of gains and conformation is to be made, selection will be necessary for both rate of gain and conformation. There is a relation between rate and efficiency of gains such that some improvement in efficiency could be expected from selection for rate of gain.

11. Larger cows of the same age and cows in their prime produce heavier calves at weaning than smaller cows, young cows or old cows.

12. Electrocardiographic studies show that animals selected for increased rate of gain have increased muscular mass which puts heavier demands on the heart but these animals do not have increased heart muscle development and are approaching the state where there may be cardiac insufficiency if the animals are put under exercise stress. It may be necessary for breeders to consider heart function in their selection program in the future.

13. A lack of protein in the diet does not prevent the anterior pituitary from producing its protein hormones.

14. Cattle vary greatly in the slope of the growth curve. It appears that animals that establish and maintain a high rate of gain are the best prospects for replacements. There appear to be some causes which prevent animals from making continuously rapid gains and which keep some animals from ever making rapid gains.

Oregon Agricultural Experiment Station

Cattle Inventory - June 1969						
Breed	Hereford		Cross-bred	Angus	Charolais Cross	Total
Line	2 s	1 s	H♀ X A♂		Ch♂X(HorA♀)	
Purebred or grade	Pure-bred	reg. pure	Cross-bred	Pure-bred	Crossbred	
Bulls (12 mos. or over)	3	3	1	2	1	10
Cows (2 yrs. or over)	27	27	18	22	6	100
Heifers (yearlings) 1 - 2	4	4	-	5	-	13
Calves - Bulls	12	8	7	13	3	43
Heifers	13	7	10	8	2	40

Cow Production Data - 1969 Calf Crop						
Number cows bred to calve						
As 2 - yr. - olds	-	-	-	2	6	8
As 3 - yr. - olds and up	27	21	18	20	-	86
Number calves born from:						
2 - yr. - olds, Alive	-	-	-	2	5	7
Dead	-	-	-	-	1	1
3 - yr. - olds and up, Alive	25	15	17	19	-	76
Dead	2	1	2	-	-	5
Number of calves weaned	25	15	17	21	5	83
Percent calf crop[a] - Born	92.6	71.4	94.4	95.5	83.3	88.3
- Weaned	100	100	100	100	100	100

Preweaning Performance - 1969 Calf Crop						Average
Birth weight - Bulls	73.2	76.7	65.7	70.6	84.0	73.4
- Heifers	73.3	77.3	60.2	69.6	78.5	70.2
Weaning age - Males[b]	197	174	223	174	167	187.6
- Heifers	190	183	213	168	151	188.2
Weaning weight - Males[b]	383.3	405.6	370.0	424.0	350.0	395.4
- Heifers	374.4	375.6	329.0	392.0	327.0	364.4
Suckling ADG - Males[b]	1.56	1.89	1.37	2.08	1.57	1.75
- Heifers	1.62	1.74	1.32	1.97	1.66	1.64

a Indicate method of calculation

b Indicate bulls or steers

Oregon Agricultural Experiment Station

Postweaning Performance - 1969 Calf Crop									Average or Total	
Breed	Hereford				Charolais Crossbred		Angus			
Line	2 s		1 s							
Sex	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Method of feeding (Group or individual - pasture or feedlot	Individual Feedlot						Individ. Feedlot			
Number on test	11	13	8	7	2	-	13	8	34	28
Average age on test	210.9	206.7	190.3	201.8	183.5	-	188.2	179.1	195.8	197.6
Initial weight	450	400	450	400	450	400	450	400	450	400
Days on test	115.2	152.2	116.8	150.8	101.0	-	119.6	151.5	116.8	151.7
Average daily gain	3.04	2.27	2.97	2.23	3.40	-	2.92	2.29	3.00	2.27
Feed efficiency:										
TDN/100 lbs. gain	5.88	7.37	5.96	7.01	5.43	-	6.03	7.18	5.93	7.22
Final weight	812.2	755.5	812.3	752.4	819.5	-	811.5	755.0	812.4	754.6
Final score - Condition	12.21	12.72	11.90	12.73	13.91	-	12.23	12.52	12.24	12.67
- Conformation	12.18	12.58	11.87	12.59	13.91	-	12.15	12.42	12.19	12.54

5. Meat Quality.

It was found that in animals 12 to 18 months of age, rate of gain immediately prior to slaughter had little influence upon tenderness. It was also found that marbling had practically no influence upon tenderness in animals of this age. No great differences between sire groups have been found in tenderness, press fluid volume, or flavor in the University Hereford and Shorthorn herds. It was also found that subcutaneous fat is thickest over the rump region in choice grade cattle and there are many significant relationships between thickness of fat over the carcass, but no one point gives an accurate indication of thickness at the majority of the other points.

V. Major Publications: (1969-1970)

Bennett, James A. 1969. What about crossbreeding? The Utah Cattleman, June, 1969.

Harris, R. M. and J. A. Bennett. A mechanism for extracting muscle tissue from live bovine. J. Anim. Sci. (in press).

VI. Application of Results:

The finding that selection on the basis of performance under a mild inbreeding system (approximately three sire herd equivalent) prevented serious depression in birth weight and subsequent rate of gain with increasing levels of inbreeding is of value to purebred breeders and has theoretical significance.

Refinements in performance testing techniques particularly in the measuring of efficiency are helpful to the industry in attempting to bring about improvement in this important phase of production. The knowledge that two strains of cattle of different growth rates (Charolais and Herefords) do not differ in their ability to digest feed nutrients provides part of the base on which to understand production ability.

Accurate estimation of body composition in live animals is useful in estimating carcass qualities and is related to gain and efficiency. Demonstrating the NAAP and tritium oxide are reasonably accurate for making such estimation is of value to the researcher although the methods are too complicated for field use.

Demonstrating that, in cattle of 12 to 18 months of age, rate of gain immediately prior to slaughter had little influence upon tenderness and that marbling had no significant influence upon tenderness in animals of this age is of importance to all phases of the beef industry. It suggests that U.S.D.A. beef grading standards should be carefully reviewed.

WASHINGTON STATE UNIVERSITY

I. Station: Washington Agricultural Experiment Station

II. Project title: Comparison of breeding systems for improvement of beef cattle.

III. Personnel:

Experiment Station:
C. C. O'Mary, Project leader and Dan Coonrad, Herdsman

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado:
Bradford W. Knapp, Acting Investigations Leader

IV. Major Accomplishments:

Production testing techniques and procedures have been developed which have provided guidelines for the beef cattle industry. Some specific accomplishments and knowledge gained follow:

Weight, age and time constant test were compared using rate of gain and feed efficiency as major criteria. The data indicated that an age constant test, or a weight-constant test would be better than a time constant test to use in performance testing bulls. The major problem encountered in the weight-constant test was in getting weights within a narrow limit at initial and ending weights. In the time constant test animals varied too much in age to get good direct comparisons. Other factors studied which affected rate and efficiency of gain were ration, sire, sex of calf and weather conditions. An all pelleted ration of 50% roughage and 50% concentrate could be used for feeding animals on production tests if supplemented with about 2 lbs. of hay or straw per animal per day. The pelleted ration saves labor in feeding, but caused some bloat problems. The addition of hay or straw lessened the incidence of bloat.

Sire differences were found which indicated that progeny testing would be especially helpful in selecting sires to increase beef production.

Sex of calf differences consistently showed bulls to grow at faster rates prior to weaning than did heifers.

Weekly average gains and feed required per pound of gain along with the weekly average maximum and minimum ambient temperatures, when plotted as curves, revealed that during the first 8-10 weeks of the trial fluctuations in environmental temperatures outside of

the comfort zone of 30° to 60° F affected rate and efficiency of gain adversely.

Studies involving the cow herds showed that body measurements can be useful in evaluating growth and development in cows, which in turn are indicative of certain performance traits of their calves. Of 15 cow measurements studied, three showed promise as being related to weaning weight of calves. These were length of shank, circumference of forearm and length of rump.

Adjustment factors were studied with respect to age of dam and weaning weight of calf. Two year-olds and three year-olds produce lighter calves at birth and at weaning than do mature cows. Ration of dam was shown to influence birth weight of calf when cows were fed peavine silage alone vs silage plus hay with the cows on silage alone producing the lighter calves.

Studies showed that excessive fatness can have variable effects on two year-old bulls. The semen from fatter bulls showed a significant negative regression of motility on time. Sperm concentration and volume were not affected.

In the early years of the W-1 Project the bulls were chained to their individual feeders. In later years a new facility was constructed with each bull being individually penned. The latter saves considerable labor in handling bulls but requires more space.

In addition to work at Washington State University, Cooperative projects were carried out with Colorado State University on bovine lipids, with the University of Hawaii and Monty Richards on sire differences, and with Carnation forms on growth and weaning data on calves.

V. <u>Major Publications:</u> (1969-1970)

None.

VI. <u>Application of Results:</u>

Results obtained during the period of time W-1 has been in existence have been put into practice in the State Performance Testing programs. Data obtained have served as useful guidelines in establishing correction factors for age of calf, age of dam, and sex of calf. Management practices have been established to give guidelines on ration formulation, labor saving techniques and on facilities planning. The use of performance testing has been of a great help in the selection of both bulls and heifers that will be more productive. Progeny tests have pointed out that large differences do exist in the performance of offspring from different bulls and that more cattlemen need to employ such tests.

UNIVERSITY OF WYOMING

I. Station: Wyoming Agricultural Experiment Station, Laramie, and Gillette Substation, Gillette

II. Project title: Criteria for improving effectiveness of selection in beef cattle.

III. Personnel:

Experiment Station:
George E. Helms, Project Leader, R. A. Field and M. L. Riley, Animal Science Division; Leon Paules, Substation Division; Brinton Swift, Veterinary Science Division; and W. W. Ellis, Biochemistry Division.

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado:
Bradford W. Knapp, Acting Investigations Leader

IV. Major Accomplishments:

The initial stages of the project involved the establishment of closed lines. Each line was established from different stocks. Using these lines other studies were made. It has been shown that scores or measurements taken on live animals were not indicative of an animal's ability to gain. It was shown that the rate at which an animal gains is highly correlated with feed conversion. The study involving the relationship of blood groups to performance indicated that no one particular blood group had any advantage in ability to gain.

Relative yield of carcass cuts were shown to differ between sires, indicating carcass evaluation should be included as a part of record of performance. In body composition studies, antipyrine, tritiated water and various bone measurements were used. None of these techniques were accurate enough to be used as selection tools. Serum creatinine levels were shown to be correlated with lean tissue, but again the correlation was too low to be used as a selection tool.

Considerable effort has been exerted to the study of dwarfism in beef cattle. Most of these studies were in cooperation with Dr. Paul Gregory. Attempts were made to identify the heterozygotes in males and females from their head forms. Although some success was achieved in males, it was not possible to identify heterozygote females.

Inbreeding studies indicated that weaning weights of calves were reduced by the inbreeding of the calf. In addition, fat composition of bull carcasses increased and area of longissimus

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decreased as the level of inbreeding increased. Other traits were not affected when selection was practiced for yearling weight and fertility. The reduction in weaning weights of cows due to inbreeding were still apparent at 54 month age.

A photographic grid was developed for recording longissimus area.

The project has demonstrated that bull carcasses from young bulls are superior to carcasses from steers and heifers. It was also shown that consumer acceptability of bull carcasses was comparable to carcasses from steers and heifers. Equations for cutability of bull carcasses have been developed. In addition, equations for predicting lean, fat and bone were developed.

It was demonstrated that selection for yearling weight caused a corresponding increase in birth weight, weaning weight and post-weaning gain. Progress in these traits were increased even though inbreeding levels were increasing. It was also demonstrated that progress could be made in small herds.

Procedures were developed for incorporating selection of carcass traits into breeding programs. This procedure involves the freezing of semen then slaughter and carcass evaluation and selection of semen from bulls with superior carcasses. Data to date indicate that selection for yearling weight is an effective method of improving carcass traits.

V. Major Publications: (1969-1970)

Nimmo, R.A., G.E. Helms, M. R. Riley and R. A. Field. 1969. Predicting cutability in bull carcasses. Proc. Am. Soc. An. Sci. (Western Section) 20:301. [(Abs. 8) J. Anim. Sci. 28(6): 854]

VI. Application of Results:

Information from this project has provided techniques for incorporating performance records into breeding programs. Procedures have been incorporated into many herds of the state. This includes commercial herds as well as purebred herds. These procedures include all phases from percent calf crop to the carcass.

Although not accepted by the majority of the industry it has been shown that bull carcasses are an acceptable product. If wider acceptance of the industry comes about, selection procedures will be enhanced. Prediction equations for cutability have been developed similar to those used for steers and heifers by the USDA. In addition, equations have been developed for predicting lean, fat and bone of bull carcasses.

Data from the selection and inbreeding studies have shown breeders that progress can be made in small herds. They have shown that weights of animals are decreased where inbreeding is in excess of 15%. It has been shown that this effect of inbreeding can be overcome by selection. It has been shown that progeny of sires from these inbred lines compare favorably with industry sires.

The studies involving dwarfism with Dr. Gregory pointed out the importance of abnormalities in beef cattle. Procedures were developed for identifying heterozygous males. The mode of inheritance of dwarfism was determined.

Several studies have involved factors related to performance. It has been shown that the most effective way to improve performance is to measure performance itself.

Since the project was initiated the beef industry has changed materially. Presently, growth rates are part of most breeding programs. The use of progeny tested sires is now common. Many breeders are in the process of proving sires. Artificial insemination is now recognized as an additional tool available to livestock improvement. Crossbreeding is receiving increased interest. The emphasis of growth, especially to weaning is partly responsible for these changes.

W-1/WRCC-1 TECHNICAL COMMITTEE MEETING

AGENDA

W-1/WRCC-1 Technical Committee Meeting

U. S. Meat Animal Research Center
Clay Center, Nebraska
August 12, 1970

Dr. C. M. Bailey, Chairman

Wednesday

10:00 A.M.	Meeting Called to Order - Dr. C. M. Bailey
10:10 A.M.	Nature of Participation in WRCC-1 Committee
10:30 A.M.	Regional W-1 Termination Report
11:00 A.M.	WRCC-1 Objectives and Participating Members
11:30 A.M.	Organization of WRCC-1 Committee and Election of Officers
12:00 Noon	Lunch - Clarke Hotel
1:00 P.M.	Station Reports
2:45 P.M.	Coffee
3:00 P.M.	Discussion - 1971 Annual Meeting
3:30 P.M.	Regional Bulletins
5:00 P.M.	Meeting Adjourned

W-1/WRCC-1 TECHNICAL COMMITTEE MEETING

U. S. Meat Animal Research Center
Clay Center, Nebraska
August 12, 1970

Dr. C. M. Bailey, Chairman

The W-1/WRCC-1 Technical Committee convened at 10:00 A.M., August 12, in the Hotel Clarke at Hastings, Nebraska. The meeting was called to order by the chairman, Dr. Bailey, who introduced Dr. Estel H. Cobb, Assistant Administrator, Cooperative State Research Service.

Dr. Cobb:

The WRCC-1 Committee was set up for purposes of coordinating and it can be pretty much what the committee wants it to be.

In justifying your existence the committee outlined some objectives. One of them was that you were going to complete some publications of W-1 material. Your future after a three-year period depends on your getting those out. You indicated you wanted to coordinate your work with the Meat Animal Research Center. You had a couple of other objectives of coordinating your work in planning and productive work.

There are no rigid formats for the coordinating committee. The major difference is that you do not have any rigid system of recording. It is up to you what you report and how you record it. You can continue the way you have been doing or you can reduce some of the reporting and spend more time on planning.

The main difference at the station level is that the Directors can no longer assign funds to your work from regional sources. They can send you to these meetings but they cannot extend regional funds. This does not mean you have less support. It is entirely up to the Directors how much support you get. They can find funds from other sources to substitute for the regional funds if they choose to do so.

I think after the discussion of the last two days that we are all of the opinion that more coordination is needed, and possibly the best way to do it is on the scientist level, the way it has been done for years. Get together and decide what you want to do and then go after the support of the administrators.

[illegible]

Dr. Bailey:

The next item we perhaps should discuss is the topic of interregional cooperation in evaluating different breeds. Dr. Koch had thought perhaps it would be desirable to implement Dr. Dickerson's suggestion on having a committee or interregional project on evaluation of breeds and breed accommodations in different environments. There are people that are interested in this, and we wondered if individuals in each of the three committees would want to participate in this sort of thing? After we find out who are interested, then the next step would be to schedule a meeting of those people who want to participate in an interregional testing program involving breeds and accommodations, work out a coordinated program, and then carry this back to the administrators at our respective stations. Roughly, this is one proposal that has been made.

Dr. Burris:

It seems to me there might be other problems that were just as important on which the group might want to get together. Someone who has an interest in a particular subject could serve as a focal point, make contact with everyone, send them a questionnaire, and ask are you interested? I can't see picking out this one particular area and saying this is one that we are going to try to get as a regional project. I think this is out of the question. You can get this cooperative effort, but I don't think it is going to be anything formal like what we call a regional project.

Dr. Bailey:

I think it has been informal to this point. Obviously this seems to be an important area of endeavor. The idea was that instead of everyone going in a different direction, this might be coordinated. This was one of the reasons for getting together at this time, to try to map out some kind of plan. This would give us an opportunity in going to our Directors to say: we want to do this, this would be an integral part of a total program carefully coordinated, and these are the benefits which would accrue to this station. Certainly there are other areas of interest, but this would be one where it would be quite important to have a cooperative program.

Dr. Bogart:

Could the Administrative Adviser prepare some kind of a guide sheet so if we had a particular thing which we would like to work with other people on, we could proceed in getting this cooperation. I don't think it needs to be a highly formalized thing. We could lay the background so anyone that had any particular interest in an area would know how to proceed.

Dr. Bailey:

I am sure this is true but the basic idea was to attack this breed evaluation and see what could be done. I am sure others will develop and I am sure others might well stimulate an interest such as there is in this particular subject. What harm would there be in trying to get this type of program going?

Dr. Bogart:

Is it your idea to take one subject and use it as an example to find out how we could proceed?

Dr. Bailey:

Yes, among other things, this would be accomplished I think. We will have this notice about this meeting if it does occur sent to everyone and you can act accordingly if you are interested. I will contact Dr. Koch and tell him that we would like to know about this meeting and some of us may want to attend and possibly set up a project of that nature. This would be strictly voluntary. It would be coordinated so we could make full use of the total program. Dr. Koch will more or less coordinate it, I hope, in conjunction with Dr. Dickerson. Also we will contact Dr. Turner from the Southern Region. I think possibly some of the people from the Southern Committee will want to participate. He will send this information out about the respective meeting, if this can be done.

The next item that we had scheduled was to give state termination reports. A number of people have expressed the opinion under the circumstances that we could forgo these since we already have the full written reports. Unless someone wants to give a report or discuss them, we will not go through the termination reports. As I understand it, this year we will go ahead and print an annual report which will consist of our termination report and in addition it will have the joint session reports.

Mr. Knapp:

Yes, this will be your last report for W-1. In talking with Dr. Cundiff and Dr. Butts we decided the first part of it will be made up of the talks of the joint meeting. All three regions will have the first same sections. We will put our termination reports from each individual station and the minutes of this meeting in the back of the report. From this we will make up a termination report to be sent to CSRS and the Directors.

Dr. Bailey:

Are there any other questions about the state termination reports that should be discussed right now? We will talk about the original terminal report next.

Mr. Knapp:

We actually sent you the form of the report that CSRS requires in their manual. We will take each station and combine these station reports into one large final report to send to the Directors and CSRS. We will summarize the publications in a table form by each state and then we will list the major scientific publications. I planned on working with Dr. Brinks and Dr. Nelms on this report. I will do the major work and then have these people read it and make changes as necessary.

Dr. Bailey:

The W-1 Committee meeting is now adjourned.

At this time we will open the meeting for the WRCC-1 Committee. Dr. Burris, would you make a statement on the objectives and participation of the WRCC-1 Committee?

Dr. Burris:

The creation of the regional coordinating committee concept gives people an opportunity to get together and talk about research, planned research, and to discuss progress. It is a focal group without the need for too much overhead. There are two kinds of regional research. One is supported by a regional project and the other is in the form of a regional coordinating committee. We have a regional coordinating committee here with this group. I think we do not want to involve this group with too much administrative detail. This is a research committee not an administrative committee. Hopefully, this will provide the environment for research ideas across this group.

As far as I see it, it is kind of flexible in membership depending on what the Directors' recommendations are. I think some new people will be on this committee and some of the people that were on W-1 won't be members. We have somewhat of a free hand; it is up to this group to decide how we want to do this job. Do we want to pattern it after W-1 or do we want to be different? To some extent we used to have a little bit of a brag session in some of our regional meetings and when we got through there wasn't really an opportunity to get the type of professional advice that we were after. It is up to you to decide what you want to make of

this committee and how you can make it most effective. We don't have too many of these committees yet so if we really get the stimulation here so it looks like it is desirable, we may form the basis for coordinating committees in a wide number of diverse areas. On the other hand if it is just a talk session without any real accomplishments, then I think the whole concept may die on the line.

Dr. Roubicek:

May I ask where Mr. Knapp fits into this now?

Dr. Burris:

We will have to look at this in a broader concept. How will this group interact with the Federal group here in this committee, in Mr. Knapp's office, and in the U. S. Range Station? Do we really feel that there is a need for analysis of data on a regional basis or for coordination that we as individuals may not feel we have the time to wade through? This is something we should talk about and come up with recommendations to Dr. Putnam on the role of this office and whether we recommend that there be someone in this category and also what he should do.

Dr. Putnam:

You might go a little further than that and just put it into questions which would be helpful from our standpoint. Do you want someone in the category of the coordinator either as you have had in the past or as you may envision at the present time? If you do, I think this type of position needs to be defined in relation to the needs of the coordinating committee. Then you come to the question who should employ this man. Should he be a Federal man, should he be employed on the basis of the Directors putting in a full day's salary, or should he be a state man assigned to this task? There again is the point that I raised about what should be the Federal participation in the coordinating committee activities? I think this would be very useful particularly under the conditions that now exist in relation to our personnel ceilings. I would certainly appreciate any statement or recommendation that you folks could work out along that line.

Dr. Bailey:

I wonder who will be the members of this committee? We had talked about continuing with the previous W-1 members if they wanted. We suggested that we appoint a statistician with a background in animal breeding. We also recommended the appointment of an economist to the committee. Do you have some information on that?

Dr. Burris:

I wrote to all of the Western Directors to convey this to them, asking them for names of people from their station that would be on this committee. About all I got in the way of these two categories on a statistician and an economist was a comment from Mr. Knapp that Dr. Gary Richardson, who is with the U.S.D.A., A.R.S., Biometrical Services, in Fort Collins, could make a very good input in this committee as a statistician. I haven't had any input from the stations about an economist. Maybe some of you people would have someone from your own stations from these two categories that could make a real contribution to the committee.

Dr. Bennett:

Have you received names from each station on membership of this technical committee?

Dr. Burris:

If they didn't submit a name, I assumed that it was going to be the W-1 member. I got replies from at least 8 or 10 of the group. I assume that since most of you are here, your Director said you were the one.

Dr. Brinks:

I move that we invite Dr. Richardson through the proper channels to become a member of this committee in the capacity of a statistician.

Dr. Bennett:

I second the motion.

Motion carried.

Dr. Bogart:

I move that we request the services of Mr. Knapp to help us with our data so we can get our regional publications out.

Dr. Bennett:

I second it.

Dr. Bailey:

Does this imply that this would be just through the completion of the analysis of data for the publication or on a continuing basis?

Dr. Burris:

This project is only going to be for three years.

Motion passed.

Dr. Bogart:

I make a further motion that the chairman of the coordinating committee circulate to each member of the committee a questionnaire to determine whether or not we want a coordinator.

Dr. Bailey:

Will this be sent to the member and then will he contact his Director and ask him his views on it, and will it then be collected by the chairman of the committee? What is going to happen after these replies come into the chairman?

Dr. Bogart:

The chairman would have to prepare a statement on the consensus of the committee and submit it through the proper channels. If we feel that we need a coordinator then we will contact our Directors on how this will be done or what would be best - whether he would be a Federal employee or whether the Directors would feel that it would be better for them to put money in it themselves to employ a coordinator. I don't think we would be bound by this motion to go to our Directors if we didn't want to go.

Dr. Burris:

I think if it were unanimous, and A.R.S. agreed to support the coordinator, I don't think there would be any need for going to the Directors. If A.R.S. said we don't have the money, then you would have to go to the Directors. So it might be expedient to let the Directors in on this. From your point of view it would be to your benefit if you knew if the Western Directors thought this was the desirable thing to do.

Dr. Holland:

I would rather wait and write in because I imagine everyone has a different conception of how this committee is going to operate. Today we are going to get a better idea about the committee and what we are going to do and more ideas on whether we really need a coordinator or whether the chairman can do that type of work. Maybe the thing to do is to postpone the vote on this motion until the end of this meeting after we have discussed other ideas on WRCC-1.

Dr. Bailey:

Would it be appropriate to postpone action on this motion until after we decide what we are going to do in the nature of the project, or do we want to act on it right now? We have a motion that was seconded so we will have to vote on it unless you want to withdraw it, we have no other course open.

Mr. Knapp:

The motion wasn't seconded.

Dr. Bailey:

No second, I guess we can talk about it later.

Before we go any further, it seems to me we should decide exactly who will be on the committee and who the officers will be and let them take over from there. This is actually just a little extra assignment for the W-1 chairman up to this point. What do you want to do about this? Would the next station in line be the U. S. Range Livestock Experiment Station or New Mexico after Nevada?

Dr. Holland:

I would think we should discard the practice of rotating by stations. I nominate Dr. Curt Bailey to be the chairman of WRCC-1.

Dr. Brinks:

I second the nomination.

Dr. Bogart:

I move that the nominations cease and that Dr. Curt Bailey be elected chairman for one year by acclamation.

Motion carried.

Dr. Bailey:

Then in setting this up, how will each station participate. In other words will each station submit a project or one phase of the total project that they are working on at their station and this be more or less their participation in this committee? If this is the case would we more or less continue giving oral reports on the type of work that we have been doing the previous year, and/or have a general discussion on a particular theme, and/or invite a guest to discuss different subjects on breeding or other appropriate subjects as they appear? How do we want to proceed on this?

Dr. Rollins:

I was just wondering if each station could just briefly discuss the work at their station and their plans at this time for possible cooperation.

Arizona:

Dr. Roubicek:

We do have an obligation to complete the data collection and analysis on this line top-cross that was initiated. We have all of our data on cards up-to-date. We are still collecting weights on the half-sibs that remain on the rating now. We get weights on those this fall and next spring. That completes that phase of the work. We have two calf crops from the top-cross heifers from this particular project. It is my personal feeling that we can begin to summarize this data when we get at least one calf crop from each of the top-cross heifers on each year that it started--which will be two years from now. As long as we have Mr. Knapp in the office, we will see that this data in detail gets to his office. Then we will have to determine just how it will be summarized and presented, but this we feel obligated to do and this will be done.

The status of an actual breeding project in Arizona is dim, I don't think we will have one. I think the philosophy of the department will be orientated toward nutrition, I doubt that it will actually continue much in the way of animal breeding. The work that we will be doing will be under this reproduction study. We may be able to get something involved there. I have a project in for approval but I have no assurance, in fact I am not very hopeful, that it will be approved.

I might just mention this year on the first calf heifers we had a 100% calf crop so we aren't going to get any bad fertility problem. They were bred incidentally by two of the Brae Arden and two of the Line 4 top-cross bulls; we had four breeding pastures. We had 32 heifers per bull and they were taken right off heat test and put in with the heifers at just a year of age.

Dr. Brinks:

What is your other source of bulls, are you using a lot of your own bulls now?

Dr. Roubicek:

No, the only outside bulls that are being used now are heat bulls from an Arizona rancher in the northern part of the state, other than that the ones that are being used are the top-cross and the herd-produced bulls. On the heifers this year we actually used Brae Arden half-sibs.

Dr. Burris:

Would the content of this new proposed project have any interest to this group?

Dr. Roubicek:

Yes, I would think so. There is still a unique situation at San Carlos. We have the opportunity to work with animals there without supplementation, and we can do it in any one of a number of ways. We have an opportunity there to watch this rather drastic weight fluctuation that occurs through the year. In other words we have 500 lb. weaning weights, lose 25% - 30% during the winter, pick up about 750 or 800 lbs. the following fall, and lose about 15% again that winter. A very common situation in much of the world. We also have an opportunity to superimpose on that a supplemental program in which you do not run into these drastic changes in weight. The project I proposed was one primarily of studying the genetics of growth from the standpoint of growth restriction under range conditions as contrasted to more or less regular growth. The reason we felt this was important is that if you take a look at data from countries like Brazil or Argentina, this is their way of life. If you take a look at the feed tests on Dr. Bailey's Knoll Creek bulls, it doesn't impress you very much. They aren't as good as some of the other lines. If you take a look at these Knoll Creek calves in the spring after a good tough winter, they stand out above everything else. It isn't a clear-cut matter, here are growth genes that enable an animal to grow well on the feedlot but they aren't up to snuff as far as performance under tough feed restrictions in the winter. We have had the opportunity to study this type of interaction. We still have the arrangement with the Indians. They will keep our animals as bulls if we so request for at least a two year period. We would have the opportunity to expand the project to this extent--we now have 18 single sire pastures, they would like to probably double this. If we had the funds to hire the personnel to get the data, we would have the opportunity to increase our project to about 30 single sire pastures. Also if we had the personnel and inclination, we could probably develop any kind of AI program there we wanted. The Association just over the hill at Point of Pine Commercial Hereford herd, numbers about 800 cows, would go completely AI if we were willing to work with them. There is also an opportunity to test sires.

So to answer your question, Dr. Burris, our department tried to avoid any implication of reproductive performance simply because this was a new regional project. I don't think you can separate these things. It looks to me like in this top-cross study or in any of our performance studies that this reproductive performance is such an important part that we don't separate it. It is not actually included as an important objective in the project I wrote just so I would avoid an overlap of the regional project.

California:

Dr. Rollins:

Our work at Davis is completely on this double-muscle project, mainly with the British breeds particularly the Aberdeen and Red Angus. We are doing a little work on the side with Charolais. In addition to myself there are six faculty members and their graduate students in various fields of biochemistry, muscle nutrition, muscle biochemistry, histology, physiology, reproduction, various aspects of growth, nutrition, and anatomy. As a result we are approaching this from various biological aspects and from the agriculture aspects.

The mode of inheritance of double muscling in the British beef breeds seems to be pretty clear. We are still gathering data on it, but it looks very encouraging and looks to be caused by a recessive gene. We are also gathering evidence that it may be an incomplete recessive. In the case of the Charolais breed the picture is rather murky. I think this is possibly because the Charolais start out at a much higher muscular base level. This is one of the main thrusts in the double-muscle gene, so this just might be a confusing situation. I want to stress that I think there are good grounds that this is a simple recessive, because my further remarks are involved in this assumption.

We have a 150 cow herd at Davis in which the gene is widely spread. We actually calved out 31 double-muscle animals on the place in the last few years, 17 of which came this year, so we are really in the business of producing double-muscle animals. For our purpose there is a very sharp division between the double-muscle, the heterozygote, and the normal animal. Heterozygotes are much closer to the normal than the double-muscle animal. I am talking about wide conformation now. Sometime during the first few months of age if you have a double-muscle animal and if you had adequate planned nutrition, you don't have any doubt about it being a homozygous double-muscle animal.

From the agriculture standpoint our primary interest is one that might prove of interest to you people possibly from a cooperative standpoint. It is to compare the heterozygote with the normal. From the standpoint of the production of beef is there a place for the purposeful use of the double-muscle gene? If your heterozygote shows sufficient advantage over the normal in all aspects of beef production from conception to the consumer, then there is a very simple way for operators to make use of this. Mainly the operator could use a double-muscle bull through AI on normal cows, I am speaking here of British breeds. Our results today are the results that they have gotten in France, Italy, Belgium, and in fact every-place that they have done any significant work on double muscling.

It is very interesting that double muscling doesn't seem to hurt the reproductive fitness of bulls. There is no significant decline in reproductive efficiency. The bulls have libido, their semen will freeze, and therefore, there is no problem in using double-muscle bulls as AI studs. The only reason one would not recommend them in open country is that their anatomy and physiology is against them on the range. On the other hand there is evidence that the double-muscle female has reduced fertility.

We have a subherd in which we do use double-muscle by double-muscle matings mainly for our biochemist who is working on muscle histology and biochemistry. This way we can guarantee him a double-muscle animal, because he is actually going right back as close to conception as he can to study the tissues.

I am using the matings of double-muscle bulls to normal cows and normal bulls to normal cows as a control. The 1970 calf crop is on the ground now. There are about 80 calves in the three categories of normal, heterozygous, and double muscle. All were born either from normal or heterozygous cows. I make this qualification because the double-muscle cow might not be able to raise a calf adequately. We are raising these calves to 6 months of age and are sort of simulating beef cattle conditions. The three genotypes - normal, heterozygous, and double muscle in both sets of bulls and heifers - will be put on feed at twelve months of age and we will grow them out to about high, good, or low choice for the normals and heterozygotes. The heterozygotes are going to be close enough in finishing ability to the normal that we can run them that way. We will take the double-muscle animals off on a time basis. We will get individual feed efficiency on these animals, complete body composition studies, and carcass analyses. One half of the carcass will be ground up for the chemical analysis. There will be taste panel work. In addition to this normal sample that we have, we also have a good deal of normal data from the experimental feedlot that we will be using under our nutritionist's direction. We have a lot of normal data extending over the years that will be treated in the same way and the volume of this will make a good control for us. There will be about 80 calves involved in the study from birth to yearling and we will have room to put 40 of them in the feedlot. We originally had hoped to have bulls, steers, and heifers, but this put an imbalance on the numbers in the herd so we decided we would just take the bulls and heifers and the steers as it is convenient. There is strong evidence of sexual diamorphosis affecting the double-muscle gene. We would expect if there is a superiority of the heterozygote, the difference of the heterozygote and the normal would be greater in the bulls and less in the heifers in the effects of the mating.

If this trial that we are making shows some promise on the comparison of the heterozygous and the normal, then what we will want to do is expand the trial through cooperation with private breeders, our extension service, and if any of you are interested, we could probably arrange to expand to your area also.

Next year we will have the National American Society of Animal Science Meetings at Davis. The calves I am referring to will be just about ready to go into the feedlot. You will have a chance to see the three genotypes of the two sexes plus the other animals that have been involved in the biochemistry testing.

This work is with Hereford, Angus, and Shorthorn. As you know, there is a much higher incidence in Angus and Red Angus than there is in Hereford. I am not sure about the Shorthorn. We haven't had a chance to sample them much, but there is a much higher incidence in the Angus than there is in the Hereford.

We had some excellent information on this as a single gene inheritance. We made two reciprocal matings between double-muscle Charolais and double-muscle Angus and in each case we got these extreme double-muscle calves. Another interesting thing happened when we mated a double-muscle Red Angus bull to what appeared to be a normal straight Shorthorn cow. She produced twins, one of which was double muscle, the other was normal. The double muscle calf was male and the normal calf was female. Fortunately we had data on the calf crop that she was born in, data on her and twelve female half-sibs, and data on some 20 or 24 male half-sibs.

Four years ago when we were just getting into this double-muscle work, we developed the rump gage to try to help us identify carriers. It is a series of rear ends on a transparent plastic that you hold up to and fit to the animal's rump. We indexed the animals just after weaning and just before they went on feed. We experimented with the gage on the last calf crop of our crossbreeding experiment and found these animals were completely different. Some of the bull calves had very rounded rear ends, but were normal animals. We went ahead and classified these animals. We were interested in finding how much variation we got among normal animals. These bulls and steers then routinely went on feed in the course of the experiment. When they had been on feed and had reached choice, we slaughtered them and got the carcass information. We then obtained correlations between the rump gage indexes and some creases in the muscles and the lean meat in the carcass. The correlation among the bulls was .8 and among the steers was .7. We tried this on a lot of varous animals in the feedlot and got correlations of .1 and .2. The half-sib of the cow that produced the twins also produced a double-muscle calf so we decided the Shorthorn bull was heterozygous. The correlation of .7 and .8 that I got between their body conformation at weaning and

slaughter weight 8 months later was interesting, because I got a similar correlation of that size when I used a heterozygous Charolais bull on the same cows. I feel that we have pretty good evidence now that the Shorthorn bull was heterozygous.

This fall the Experiment Station at Davis is up for a radical reorganization in relation to ecology and renewal of resources. I am hoping that they will forget about my project. I think my main assurance is that there are six other faculty members getting data from the animals in addition to myself so I hope we can stay in business. If we do, you are welcome to use some of this semen if you would like to.

Colorado:

Dr. Brinks:

Colorado will have the same beef cattle breeding project we have had in the past working with the inbred lines and linecrosses. We have some expansion in numbers. We are up to 320 over the 200 breeding cows we used to have. We will probably have several side studies going on making more use of these inbred lines and linecrosses. Right now we have one going on cancer eye, brisket disease, and several management aspects.

When the revision of this project went through, we were establishing two more Hereford and Angus lines in which we will be comparing mating systems with mass selection. This will be a continuation of our present project for this committee.

We will try to keep you up-to-date on our twin project. We are using identical and fraternal twins and getting all the production data and the gross carcass measurements when we slaughter them. Also we have many pilot studies going on right now on the twins. We take tissue biopsies on the calves every 56 days from the time we get them as baby calves all the way through to slaughter. We are getting data primarily concerned with fat metabolism. We are getting all the major different classifications of fat as well as the various specific fatty acids. We hope to get into the protein end of this a little later. I think we have about eight different departments cooperating on this so it is quite a job getting coordination.

I would like to make a comment on the committee. Colorado will be a member of this committee. I have assurance from the Department Head and Director that we want to do this. The coordinating committee may be a blessing in disguise from what we had before. We can go on doing exactly the same things we had been doing and it gives us more flexibility and maybe gives us a little less paper work. I want to make the plea that we don't get over-organized in this new committee. I would like to see us get together concentrate on the nut cracking, the exchange of ideas and reports, and keep it on a research level.

Let's don't get the committee meetings over-organized from the standpoint of bringing in discussions on contracts and grants or establishing priorities and goals. I would like to see this left to the Directors and we concentrate strictly on the research aspects. As I visualize these committee meetings, I would like to see them once a year with us getting together like we are now and perhaps concentrating on research with half a day devoted to invited papers strictly on research.

Hawaii:

Dr. Reimer:

We will continue with the beef cattle breeding project in Hawaii in much the same fashion as we have in the past. We will continue the crossbreeding study there. This will involve the same breed of females that we started out with originally, and we will shift to two different breeds of sires so we can get information on other different types of crosses.

With the termination of the W-1 program we were threatened with the complete termination of the beef cattle breeding work in Hawaii, but we did salvage it and are combining it with the project on reproductive efficiency. I think we are getting more mileage out of our beef cattle herd than earlier. It will be expanding in number, we hope to have 300 cows that will be in the program. This is slightly more than what we had in the past. In addition we are continuing with cooperative work with at least one of the ranches and possibly more. These studies will continue. I expect also that we will want to be a part of the WRCC-1 Committee if possible.

Dr. Nelms:

Do you still have the Charolais and Angus crossbreeding project at two locations?

Dr. Reimer:

Yes, we are using Charolais on Hereford-Angus cows and we were using the crossbred heifers. Also we were following the program to get full backcrosses and three-breed crosses, but I won't be able to continue that portion of the program because of lack of funds. I am going to have to get rid of all the crossbred heifers and plan on using only Hereford and Angus cows. We will be straight breeding them as well as using Brown Swiss and Hereford bulls.

Montana:

Dr. Blackwell:

Our work will continue to try to finish up the line-formation program, and the evaluation of the submitted projects will tide us over for the next two or three years. We have been fortunate I think in employing an animal geneticist who will have the major responsibility in helping us finish up the old project. We will depend on him greatly in organizing the new phase.

I think our concern right now is the evaluation of lines to find out a little more about maternal ability and this type of thing.

Dr. Brinks:

Was the evaluation of the maternal ability of those crosses at the Havre Station?

Dr. Blackwell:

No, at the Havre Station we will produce about 300 or 325 line-cross and straight-line heifers in three calf crops and keep them all. We will get three calf crops out of them before any artificial selection has been performed on them and feed out all of the steers that were produced in the linecross. Also, I think we will maintain two of the inbred lines, the Poll line and the offshoot of the Miles City Line 1.

Nevada:

Dr. Bailey:

We have had single trait selection projects at two locations for the last 15 years. We have completed analysis of the postweaning performance data from both locations and we have technical estimates of genetic changes within the herds at both locations. In addition we have sent four sets of sires from our efficiency lines developed at two locations to Arizona so we will have some kind of an evaluation on that aspect of it. We have terminated three of the lines. We have terminated our conformation line. The main justification for that at the present time would be that conformation is a very wishy-washy kind of a trait that we can't characterize or pin down very well. We have found that there has been more and more interest in growth rate such as yearly weight which has been the trait that has been selected in the conformation line. In our analyses in attempting to get estimates of genetic changes we find that there now is very little estimate of genetic change in the conformation line on a fully weight constant basis. We did have quite a few dwarfs so we didn't think there was any particular reason to continue with that conformation line.

We have terminated the other two lines at our range station out of necessity. That station is leased from the Salmon River Cattle Company, and they have complete control over the lease and over the way in which it will be handled. Up until very recently it was a relatively isolated area, and we could carry on breeding work up there. Quite recently they started to put more cattle in there, and since they have control over it, there isn't much we can say about it. It would be essential to have a massive investment in fencing up there for the sake of the integrity of our breeding project, and this won't be forthcoming. We are discontinuing those two lines for that reason.

We have kept our rate of gain and our single-trait feed-conversion line at Reno and we are crossing those and producing linecrosses to evaluate within breed heterosis in those mildly inbred single-trait lines. We propose to do this for probably four or five years which would give us 250 or 300 progeny. The heifers will be tested on a 140-day postweaning performance test and put out on pasture; and the bulls will be tested for 140 days right along side our BCIA calves. Calves come in from all over the state from selected bulls that people put on the test route. These, among other things, give us a standard to compare the bulls which are developed in our mildly inbred lines. Of course these bulls in succeeding years will be linecrosses as well as linebreds. This was a little risky, since we have been selecting for sometime now, and we didn't know how it would come out. We came out fairly well, of course, we don't know how the whole thing will continue but this is the type of program that we have through biological reasoning and financial necessity.

In addition it looks as though we may be able to purchase and to establish a full scale range station in Nevada. Our present plan, if all of these things fall in place, would be to go ahead and set up a project that would tie in with this breed combination comparison study in different areas. The breeds that we propose to use: Number one would be Hereford, of course, with some Angus combinations I expect. Also we are interested in the Red Polled breed for a number of reasons depending on the characteristics, not as a straight breed but on what this breed might make as a contribution to other breeds for crossbred production.

This is the kind of thinking we have right now. If we do realize (a) the new range station which we would own and control and (b) adequate support for this efficient beef production system project, this would be a multiple disciplinary project with input on reproduction and nutrition. We would attack it from the angle of a complete cycle study on these different combinations.

New Mexico:

Dr. Holland:

I talked to some people about supplying bulls for different projects. I sure hope this can come about. I also talked with Dr. Brinks and if I do have to close out the line, Dr. Brinks indicated that Colorado would like the line. Dr. Neumann is very sympathetic with us keeping the line.

We will continue to do the hydrocephalic work not as a formal project, but working with the ranchers in New Mexico and Texas. Hydrocephalus in industry is still a great problem.

We have two crossbreeding programs going with State money. We are maintaining straight Hereford, straight Brangus and the two reciprocal crosses there at the college ranch and Fort Stanton. We are getting information on reproduction, growth rate, and feeder grades. There is a tremendous amount of interest in this project in the University and over the State. In the second phase of this project we are taking all the heifers produced at Fort Stanton and bringing them to the college ranch and combining them with the heifers produced at the college ranch. This year we have started our first breeding of them. We mated half of them to Hereford bulls that we had brought up from the performance testing program in Bronco, Texas; the other half were mated to two Charolais. We have quite a number of matings of these cattle. This crossbreeding work will continue for quite a few years under the present project plans.

We have another group of 70 Brangus cows in a repeatability of calving study which will be maintained for a few years unless we decide they are expendable and scrap them for some other work, or to make room for the crossbreeding.

The bulk of the college ranch is in projects right now over which I have control. With the retirement of the range man there next year, the control of the college ranch will be mine for production and breeding work as I see fit. Range men or at least the present range men are generally more interested in our Fort Stanton mountain ranch than they are in the college ranch. I am very optimistic about future breeding work at New Mexico.

Dr. Putnam:

Are you going to have any interdisciplinary efforts?

Dr. Holland:

Right now we are doing a lot of efficient beef production work at Fort Stanton, There are range management studies there. We are

breeding Hereford cows to Angus bulls with a cooperator supplying the cattle. We are going to start saving these crossbred daughters this fall. The range people do want to use a bull of a third breed in an area receptive to using a crossbred bull on these cattle. I would participate on this. There are limitations when several people try to use the same cattle or the same facilities for different projects. I have traded with the range people at this time on this crossbreeding because you can't very well impose crossbreeding on a particular comparison of terminal bulls on the grazing stations the way we presently have them. I would like to say again that we decided to keep the old lines in case anyone wanted to evaluate the old lines.

Oregon:

Dr. Bogart:

The status of the Oregon project is uncertain. My Department Head is quite interested that I continue with beef cattle breeding work, but the Director tells me the $7600 from the regional money will not be available and Dr. Oldfield tells me that there is nothing in the department to make up the $7600. I can't operate with $7600 less than I had been doing. There are probably two or three alternatives. One might be that we might interrelate this work with fertility or reproduction studies and tie in nutrition, physiology and reproduction in a related study using the same animals. The other alternative would be that we could close out the herd completely and I could spend my time studying the data that we have already collected. The third would be that I can retire on full pay. I am not sure which of the alternatives the Director wants me to do. I hope we will be able to continue the project because I know Dr. Oldfield is trying to help get the thing through.

We will be able to continue with our synthetic line of heifers and we have one based on our 1 x 2, 1 x 3, and 2 x 3 linecrosses. The other one is based on our same linecrosses plus 1 x 4, 1 x 10, and 4 x 10 like the U. S. Range Livestock Station linecrosses. We have six inbred lines, one in the synthetic line and three in the other with 30 cows per line. Although we use three bulls each year, it will eventually wind up as a two-sire line because what we had in mind was having repeat matings with the best bull so we would have essentially one bull not used as much as the other and it would wind up in the end as a two-sire line.

Our Angus line will be continued and I might say that it has continuously gone up. It has been closed for many years and calf crops each year are better than they were the previous year. The inbreeding is not high because we started out crossing with two different kinds of herds nowhere related to start the line, and then we maintained the sire line all the way through. What I hope to do if we continue with

the animals, is quite a little physiology work tying in with the University of Oregon Medical School where we are doing metamorphic trait studies, transferrins, and different materials of this type. If we continue, we will do the same intensive type of study where we know a lot about each animal and get as much data from each animal as possible. I think there is no question that the Oregon Station has made more use of each animal in the studies than most any of the other stations because of our physiological tie with the genetic work we are doing.

I would like to comment about how I feel on the regional committee. I think we should keep it plain and informal. I hope we don't get bogged down with having to make a lot of formal reports, and I hope we can have a lot of free and wide-open discussions. In the early phase of the project I think we had more of these free and open discussions than we have had in the last few years. I believe we profited a great deal from this service and this is where this committee is really going to have value.

U. S. Range Livestock Experiment Station:

Dr. Pahnish:

I will mention briefly the projects we have at the present time. Most of these projects, if they continue as the projects are written with the present objectives, will run through this three-year period. These, of course, are subject to change and continual evaluation. If there is enough available evidence to indicate that they should be discontinued or revised, then that will come into the picture; but the majority of these will probably extend well into this three-year period to reach the point of termination.

The projects involved are the linecrossing project, this is the third phase of linecrossing; and the evaluation of the rotation crossing schemes. Along with that we do need a pretty critical evaluation of the effects of inbreeding depression up to this point, and this also ties in with this regional study. The outcome of that will also determine to a considerable extent what the future of this linecrossing study will be.

The crossbreeding study is going into the third phase now. This is primarily an evaluation of various rotational crossings. The scheme will be primarily Hereford, Angus and Charolais with some Swiss breeding being used.

We have another small two-sire line used for carcass evaluation in the live animal. The selection criteria there is primarily final feedlot weight and fat thickness as determined by ultrasonic means.

The first manuscript on the genetic environmental interaction study in cooperation with Florida is prepared at the present time.

There has been some overlap of the projects with the reproduction work. Some of these projects supply livestock and information for the other projects. Some of our physiology personnel will be making observations on the animals we are using in these various projects. This is not final at this point, but there is some consideration of taking the surplus mature animals coming out of the crossbreeding project and running those through the individual feeding units. We would have observations on these going in at weaning time, and on the bred animals that we would calf out in this unit. We would carry the calves in there till weaning time. From the observations on these measurements and skelton measurements on the females themselves we would determine if there is any change in size taking place during the period that they are in the individual feeding unit. We would have milk production and feed consumption observations on both cow and calf.

U. S. Meat Animal Research Center:

Dr. Gregory:

First of all I would like to say that we do appreciate the opportunity of participating in this new committee of the Western Region. I think this committee will provide a mechanism that will enable us to get idea inputs into the evolving program here at the Center so we will have the full range of thinking represented that we want in developing our program.

We will expect to contribute to areas of work and we are certainly flexible in regard to areas of work that we do have in progress now. You know generally what the areas of work, the facilities, and the opportunities are. The challenge here isn't just for the people that are directly involved at the Center but for the entire animal science research community in regard to the most effective utilization of these resources. It is our real interest in seeing that we get maximum return from our investment, and we certainly look forward to contributions from this committee to the program. We look forward to cooperation at levels involving your specific stations and some facets of the program here at the Center. I hope there is not any danger of the administrative people getting the thought that the high proportion of animal breeding or beef cattle breeding research can be done here. Obviously this is not possible and has never been conceived as being possible. We think that we are just another operating unit that has real potential to make a contribution. We should always be looking for improved structures or mechanisms in regard to organizational structure to most effectively provide for joint planning and cooperative execution. I think that we would say generally that our regional technical committee system has been quite effective.

My feeling in regard to germ plasm evaluation is that we have the structure here for that. The word interregional project was used, I don't think it was intended, but it does require some degree of formalization which I don't think was indicated. You have indicated an interest in an area of work in regard to wanting to participate and plan jointly so we do get the most effective use of resources from scientists from different locations or different administrative units that relate to this specific problem.

Our thought is that we would put a person on this committee. We have such a person on our staff who would be directly involved as a research scientist in the breeding research program here at the Center in beef cattle, sheep and swine breeding. He may not be spending full time on beef cattle breeding research, but a component of his time would be there. This would be a person that we would expect to maintain effective cooperation with this group and get idea inputs from this group.

Dr. Roubicek:

Do you have any plans immediately in the future for laboratory breeding type animal research?

Dr. Gregory:

Yes, we have facilities for small animal work. Our approach, as we now see it, is that the facilities are not going to be labeled physiology, nutrition, or genetics but as the need arises priorities will be assigned in regard to use of these facilities for various areas of work. We would not have a staff that was directly concerned with the operation of the small animal laboratory facility, but rather as a scientist gets faced with a problem where this is the appropriate approach, we would have the tools there available to him.

Dr. Bailey:

What will be Clay Center's participation in this coordinating committee? Do you see this as cooperation in taking one of your projects and discussing this,or would you prefer to have you or your representative more or less keep the group up-to-date and discuss your total program in detail.

Dr. Gregory:

I hope that it will be the latter and I would want you to make inputs into the latter. It would suit us best from the standpoint of what we would get from you if we have it on a program basis. How do you folks want it?

Dr. Bailey:

It seems that the program system would be best for us also. I have another question. Is there any reason that we can't get together to try to lay out an interregional program involving people from different regions in the total planning for this breed combination evaluation on an informal basis?

Dr. Gregory:

This is exactly the way we think it should be handled. The interest was indicated here this morning that all of you would like to receive information in regard to setting a date for a meeting where this topic would be given attention. I think we would be making a mistake if we try to overformalize that type of cooperation. You certainly can't call it an interregional project.

Dr. Bailey:

This will be interregional in the sense that people from different regions may get involved in the picture, but as far as saying that it is in the administrative sense an interregional project I don't think that is what anyone had in mind.

Dr. Gregory:

I hope that our representative from the Meat Animal Research Center as a member of this committee would attend all the meetings and that you would meet at the Meat Animal Research Center periodically if you so desire.

Utah:

Dr. Bennett:

At Utah we have somewhat of an uncertain situation. However, we do have some money for this next year and during this next year we will be working over revisions past and future. We have prepared a project on reproduction. This will be a cooperative project with nutrition, physiology and veterinary science. It isn't funded, I don't know when it will be. I understand the veterinary science people have a project dealing with reproduction and embryo losses that will be terminated in a year or two. This project plus whatever we add on to it will replace them.

We are also looking at a new regional project in the marketing phase. Some of you might not be acquainted with this. This project, as I understand it, has been approved by the Directors. One phase of this is called the production phase. This is fairly broad and leaves

us room for some parts of breeding to be worked into this. I think that one of the criticisms that could be leveled at W-1 is that we didn't stick very close to economics, and I think it is time we tie beef cattle breeding in closely with economics. I was impressed with Cartwright's report on this linear program. I think we can get some help from them and they do have some techniques and information that we can put to good use. Maybe by associating with this project we can capitalize on some of this.

We just recently revised our project in the area of efficiency. I think we have the possibility of getting more efficiency of utilization of nutrients in relation to growth. I might say we have a report completed on the digestive trial with yearling Hereford and Charolais heifers. We compared the two under two different levels of nutrition, both were reasonably good and one was a very high level of nutrition. No one has proven it or shown it as far as we could see before but we found there is no difference in their ability to digest nutrients on two levels of nutrition. We ran this with a detailed study of individual feeding and checking. Some Charolais heifers gained over four pounds per day.

Washington:

Dr. O'Mary:

I talked to our Director before I came to this meeting and he didn't give me any direction one way or the other. The work at Washington State is tied into a herd of about 150 cows there at the college. We have moved our Shorthorn herd over to Prosser where they are working with them on irrigated conditions where Dr. Heinemann is doing primarily nutritional work. There at the college we still have our Angus herd. We have our Hereford herd in Pullman. We have a little less land there at the college because of the airport extension and because of the golf course. Since our herd is funded primarily with both teaching and research funds and I don't know which cow goes to which fund, I assume that it is going to continue more or less as it is. We will continue to try to get some of the data that we have collected over the years analyzed and summarized.

We have sent out some semen to a cooperator working with the University of Hawaii. I don't know how long we will continue with this at this point. They are interested in getting semen from some of the bulls that we are testing. There is one little problem, I wish we could get our schedules a little closer to theirs because we can't get the semen to them early enough to get the data back on the bulls quite as early as we can from our own group because of the difference in the breeding season. Nevertheless, we have been interested in some of the results from the bulls that have been tested under their conditions versus our own.

We were interested in trying to get some cooperator herds in a crossbreeding experiment. One of the big problems at the present time is that the professional people in the area have located some of those herds and are able to give them a better deal than we are. For example, there are quite a number of herds that are being bred to the Simmental and I understand they are getting a premium of 5¢ a pound.

We do have facilities where we can individually test and individually feed about 35 animals. We are also weighing our cows and calves at monthly intervals to obtain additional data.

A development that you might have some interest in is that we have obtained a 800 acre farm south of the college. This will be split up into sheep, swine, cattle both beef and dairy, and horses.

Wyoming:

Dr. Nelms:

I have assurance from my Director that we at Wyoming are going to continue as we have in the past. Our projects are involved around the selection for carcass improvement traits. The herd at Gillette is being continued as a closed line. It is used not only in the breeding project, but also in the evaluation of potassium studies so we do use some interdisciplinary effort.

The project at Laramie may turn out to be more a study of brisket disease than anything else. I understand Dr. Bennett is doing a little brisket disease work in Utah also. Some years we get as high as 10% loss in our calves. I don't know whether it is getting worse or not, so I have a project which will be starting this fall with some enzyme studies. One of our pharmacists is interested in the means of controlling brisket disease. I don't think you can ever control it, because usually by the time you recognize the disease the calf is beyond recovery. There is the possibility that we can alleviate the symptoms long enough to get it to market.

Dr. Bailey:

Dr. Putnam would you give us your thoughts on the evolution of this committee and give us some idea on how we should continue with the reproduction project or any other project?

Dr. Putnam:

I believe in this committee informality would be your most successful watch word. I hope it will stimulate some of this discussion that Dr. Bogart said was in the committee in the early

years of the W-1 project. I agree with everyone that this is the best opportunity you can get. If it does develop that you do true cooperative research in the definition of physically planning and cooperating, this is something else, but there is no reason why this can't be done under the same basis, independent of financing and support of regional projects.

Dr. O'Mary indicated earlier that he wasn't particularly familiar with the proposed regional research project on reproductive performance of beef cattle which is now W-112. I will just read the definition here, "It differs from established practices in the regional research system. All objectives are broad in scope and involve the services of scientists from several related disciplines and gradually may replace to some extent projects whose investigating subjects are included in this range." The Directors did approve this. It is interesting if you look over the committee, everyone falls into one or two categories either veterinarian or reproduction physiologist. I am not quite sure if the Directors have been as successful as they would have liked to have been when they originally conceived this approach.

Dr. Burris:

It is an attempt whether it is successful remains to be seen. I would like to see more interdisciplinary effort in a lot of things particularly in the area of nutrition. This is a real vital area both from the disease and the physiology aspects.

Dr. Brinks:

I think the Directors were looking for a very cooperative nature in research but on the scientist level in our location I don't think the Directors got this.

Dr. Gregory:

How has the reproduction research in the Western Region been organized?

Dr. Burris:

There is now W-95 in physiology.

Dr. Rollins:

It is a dairy project dealing specifically with dairy cattle.

Dr. Putnam:

You might be interested in a couple of breakdowns here. There are 234 projects related to this area of reproduction in beef cattle, 27 are in nutrition, 99 in physiology, 57 in disease, 32 in breeding, and 19 in other fields. There are an increasing number of breeding projects related to this as you are aware. In addition to those projects there are other projects, W-88 - Enteric Disease of Neonatal Calves, W-95 - Endocrine Mechanisms Controlling Bovine Reproduction, and W-100 - Immunity to Bovine Fibrosis, which are related to regional projects. I would think this coordinating committee would want to be aware of their activities.

Dr. Bailey:

At this point we should decide on the rules on how we are going to proceed or participate. Will we more or less at our annual meetings review the status of our projects as appropriate during this three-year period, talk about the regional bulletins and their progress, and possibly have a special topic or invited speaker? Perhaps Mr. Knapp's office could prepare a summary statement of the meetings including the major points accomplished.

There is one other item and that is the annual meeting. Shall we have an annual meeting every year like we have done?

Dr. Brinks:

I would be in favor of having a meeting every year.

Dr. Bailey:

Do you want to specify the next meeting time and location or hold that until a later date? Next summer the National Meeting of the American Society of Animal Science will be at Davis. Would you want to tie this meeting in with our coordinating committee meeting? We would be glad to have the meeting at Reno.

Dr. Bogart:

I move that we accept the invitation by the Nevada Station and that we meet ahead of the American Society of Animal Science Meeting and leave arrangements up to the personnel of the Nevada Station.

Dr. Bennett:

Seconded.

Motion passed.

Dr. Bailey:

Do you have any ideas on the length of the meeting. I suppose the registration and preliminaries of the National Meeting start on Sunday afternoon don't they?

Dr. Bogart:

Couldn't we meet at Reno on Friday and then go over to the National Meeting on Sunday?

Dr. Bailey:

Is that agreeable with everyone?

Vote in affirmative.

Dr. Bailey:

The next thing we have to talk about is the Regional Bulletins.

Dr. Brinks:

The only thing I finished since last year was this table on the origin and history of these lines. We talked before about putting a lot of this material in the Material and Methods Section into tabular form so we wouldn't have a lot of written discussion. A table like this would then go into the appendex. I am working on a table to summarize all the data on your data questionnaires on precipitation and altitude into a similar type table, which would again probably be three or four pages that would go into the appendix to describe the station and the management systems. If you will look this over, I would appreciate comments on it. Do you think this is complete enough on this particular title on the origin and history of the lines? I would think we would need one page in the bulletin describing this particular table and just refer to this.

Dr. Burris:

Would other information on each line be desirable? I can see where some of these lines may have practiced sire-daughter matings for two or three years or may have practiced no full sib matings. Some of these things might be rather indicative. I am not sure what this page is suppose to do. Maybe it is to give sort of a summary on these cattle and this is all you need.

Dr. Brinks:

That is a good point. How much detail should we go into when describing these lines?

Dr. Bailey:

You could put this in similar tabular form couldn't you? In other words the average rise in inbreeding of calf of dam per year in a column, then as Dr. Burris suggested, sib-matings, full sib matings avoided, half sib matings avoided, or combination of selection in another column.

Dr. Brinks:

What I had envisioned here was two tables. One on the management data, precipitation data, selection practices, etc. with a description by station. The differences in line could be pointed out in that. Then there would be a second table that would get into the discussion of the means of inbreeding, the range and level of inbreeding, standard deviations, and average rate per year of inbreeding.

Dr. Bailey:

Some other business is trying to set up 3 or 4 other regional bulletins. We should decide whether this would involve analyses, a review of published articles, or possibly both. Also we should decide who would have the responsibility of carrying this through and whether we want to go ahead according to our original plan and work on these specific bulletins or whether we want to add some or delete some. I think we all acknowledge and appreciate all of the effort on the part of Mr. Knapp, Dr. Brinks, and Dr. Richardson. When we first talked about this we lined out, in addition to this bulletin on inbreeding, one on selection, one on heterosis, and one on genotype-environmental interaction. Since then a couple of us have tossed up the idea of having a new revised or overall regional bulletin summarizing all of the W-1 research through 1970. Also we should think on the schedule for completion of these. Someone has said if we are going to get future support for this committee after the three years are up, we should finish these bulletins. We originally set this up in 1965 and we haven't really completed anything.

Dr. Brinks:

This item was discussed at the New Mexico meeting, and we decided that different people would work on different ones, but none was assigned. I have this committee report that was handed out at that meeting. It listed the four bulletins that we planned at that time. The first one was the effect of inbreeding, the second was the response to selection, the third one was hybrid vigor in linecrossing and topcrossing and the fourth one was the importance of genetic-environmental interaction. What the committee had in mind at that time was that all the semen going to Wyoming, Hawaii, Oregon, and

Arizona from the same bulls would be used to get the importance of the genetic-environmental interaction. I believe we could drop the fourth one because of lack of data. This would leave us just the other three. Since the genetic environmental interaction was an open project, the only data we have is between feed levels.

Dr. Bailey:

Arizona could handle that.

Dr. Brinks:

Right. My other thinking is that the second and third one might not take so many analyses, just an assembly of the existing data. There are three stations with selection data, they are New Mexico, Nevada, and Miles City.

Dr. Bailey:

First you say that we can drop the genetic-environmental interaction as a full bulletin, and Dr. Roubicek could take care of his subject in Arizona?

Dr. Roubicek:

All I said was that I had all of the data collected and I will see that each of you get a print of it.

Dr. Bennett:

What is the overall bulletin?

Dr. Bailey:

We originally talked about these four we just mentioned, the inbreeding, selection, heterosis, and the interaction. A couple of us talked about preparing a revision of this Regional Bulletin 73 and bringing it up-to-date to include the total project which would include approximately 10 more years of work. Dr. Bogart did this bulletin before and I am sure he would volunteer to do it again. Regional Bulletin 73 covered everything up to about 1960; whereas, this one would cover the whole project.

Dr. Brinks:

We have a ten-year summary that covers the last ten years.

Dr. Bailey:

I wouldn't see any reason to just include the area from 1960 to 1969, why not the whole thing? Of course some of it would be somewhat obsolete and some of the projects would have additional data. That earlier material would be included in the whole thing.

Dr. Brinks:

I move that we revise the bulletin and Dr. Bogart serve as the chairman of that committee.

Motion seconded.

Motion passed.

Dr. Brinks:

I move that both this response to selection and heterosis between lines which has been published be incorporated into this updating of our regional bulletin on our accomplishments. So we would only have two bulletins on a regional basis, one on inbreeding and the other on the updating of the old bulletin.

Dr. Bailey:

Do you want to go ahead on that basis with Dr. Brinks getting out this inbreeding bulletin and Dr. Bogart having the responsibility for tying all of the rest of this stuff together?

Motion seconded.

Motion passed.

Dr. Bailey:

We have a couple of more items. One is the matter of the Regional Coordinator. Should we recommend the appointment of one and what kind of duties would he have? Would he actually travel around and consult with people at different locations, would he be primarily involved with work in data analysis, would he be a public relations expert, or what duties would he have?

Dr. Brinks:

I make the motion that we go ahead and keep the original structure which was very effective.

Dr. Nelms:

Seconded.

Dr. Brinks:

The coordinator would do the same as he did in the past, work with Miles City and coordinate the committee. I would say we would do exactly the same thing only we wouldn't have regional funds and we changed our name.

Motion passed.

Dr. Roubicek:

Upon consultation with the rest of the committee I have the following resolution, "Be it resolved that members of WRCC-1 Committee express their sincere thanks and appreciation to the personnel of the Meat Animal Research Center for their efforts in arranging the program and tour for the interregional joint meeting, and we request the chairman to send letters expressing our feelings to Dr. Gregory and Dr. Cundiff.

Dr. Bogart:

Seconded.

Resolution passed.

Meeting adjourned.